COMMITTEE OF COUNCIL ON EDUCATION

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MANUAL

OF

MODEL-DRAWING.

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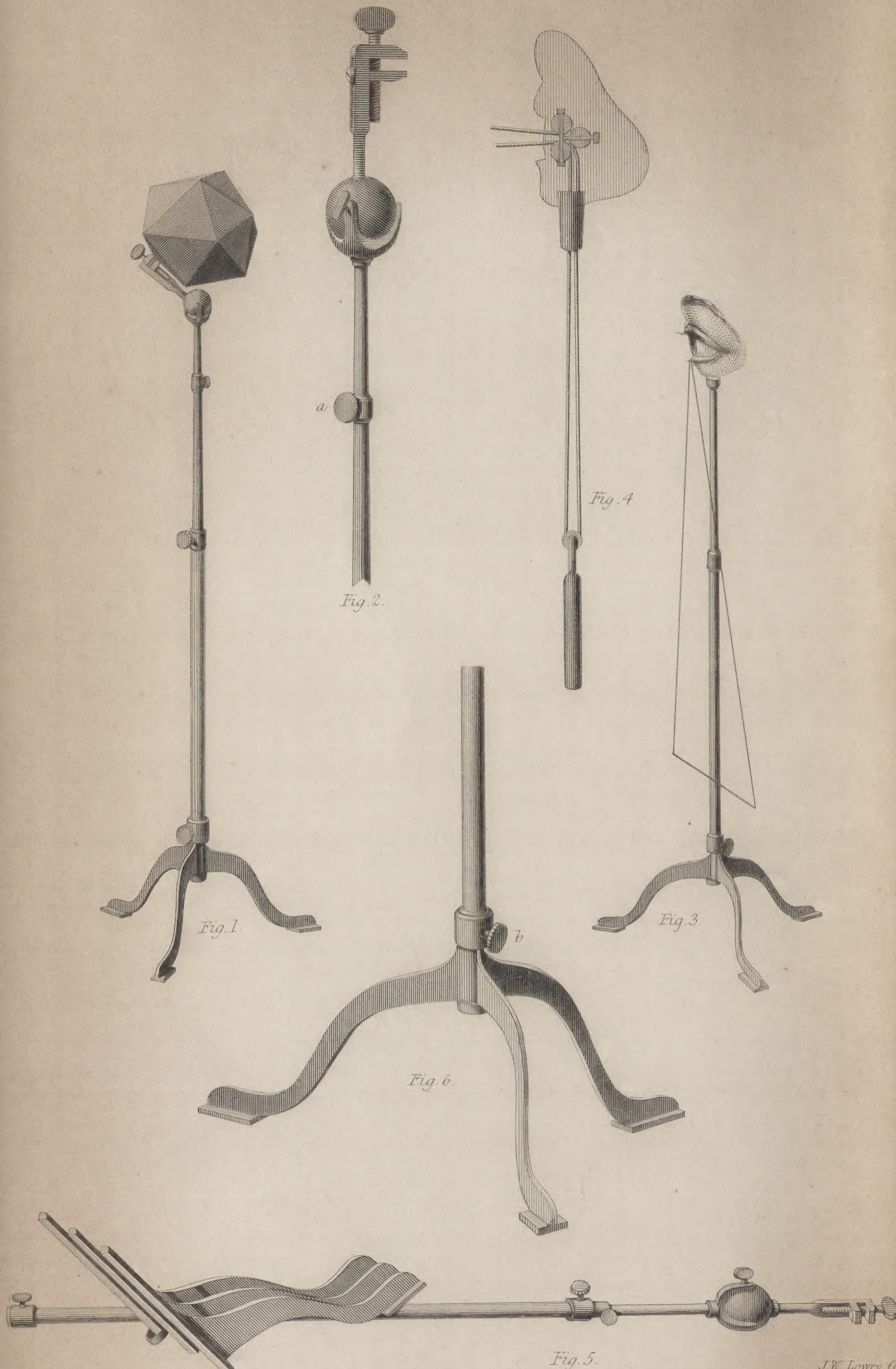
MODEL-STAND, AND EYE-MODEL



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A MANUAL

FOR TEACHING

MODEL-DRAWING,

FROM

SOLID FORMS,

THE MODELS FOUNDED ON THOSE OF M. DUPUIS;

COMBINED WITH

A POPULAR VIEW OF PERSPECTIVE,

AND ADAPTED TO THE

ELEMENTARY INSTRUCTION OF CLASSES IN SCHOOLS
AND PUBLIC INSTITUTIONS.

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"PRACTICAL GEODESY."

UNDER THE SANCTION OF

THE COMMITTEE OF COUNCIL ON EDUCATION.

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PREFACE.

This Work being designed to introduce a Method of Teaching Drawing, in a great measure new, it has been deemed proper to commence with a short account of the various methods hitherto adopted, and to bring under consideration the reasons which countenance the introduction of the plan herein proposed.

The fundamental principles to which it has been the endeavour of the Author strictly to conform may, however, be stated here in few words.

First,—The theoretical investigations and the practical exercises are presented, each according to an exact synthetical progression, the pupil being supposed, at the beginning, not to possess the least knowledge of drawing or perspective.

Secondly,—The pupil is to draw all the exercises of the Course solely from models or actual forms.

This second condition made it necessary to devise a system of teaching perspective, in which the science should be divested of its abstract form, and made applicable to the immediate practice of the Course. Ocular demonstrations, combined with the simplest reasoning, have been found capable of accomplishing this purpose, so that children and others altogether unacquainted with geometry may by this method be taught the theory and practice of perspective.

CONTENTS.

PART I. LINEAR PERSPECTIVE.

CHAPTER I.

METHODS OF TEACHING DRAWING.

CHAPTER II.

Principles of Perspective.

CHAPTER III.

CHAPTER IV.

CHAPTER V.

Application of the foregoing Principles to Practice.

Practice from Wire Models.

CHAPTER VI.

CHAPTER VII.

Further Investigation of Principles of Perspective.

CHAPTER VIII.

Practice from Wire Models—*Continued.*

CHAPTER IX.

Mechanical Aids in Perspective Drawing.

CHAPTER X.

Practice from Wire Models—*Continued.*

CHAPTER XI.

Solid Forms.

PART II. LIGHT AND SHADE.

CHAPTER XII.

Of Shaded Drawings.

CHAPTER XIII.

Of Light and Shade.

CHAPTER XIV.

Shades and Shadows.

ERRATUM.

Page 110, In the Diagram at top of page, *for* $\frac{1}{4}$, *read* $\frac{3}{4}$.

PART THE FIRST.

LINEAR PERSPECTIVE.

MODEL-DRAWING.

CHAPTER I.

METHODS OF TEACHING DRAWING.

THE comparatively rare possession in England of the power of Drawing implies, either an indifference to its acquirement, arising from a prevailing doubt of its usefulness, or a belief, founded it may be on experience, that it is an art so difficult as to be accessible only to a gifted few. The deficiency we notice may be ascribed to both these causes. As to the first, it is true that attention has of late been directed to the formation and encouragement of Schools of Design in the metropolis, and some of the important provincial towns; but all efforts to this end have been hitherto limited to the cultivation of drawing for a single special purpose—namely, its application to the improvement of patterns for manufactures.

Independently of this most important but special object, the art, except when cultivated as a profession, has been too generally considered in the light of a mere accomplishment, and not as a branch of knowledge possessing claims to a cultivation almost as universal as writing, to which it is

closely allied,—a cultivation from which all members of society would derive real and substantial benefits.

Whatever tends to improve the knowledge, and to civilize the mass of the people, will, if properly directed and controlled, improve the tone of their moral character. On this part of the subject, it were out of place to dilate in this Introduction, which will be confined to an examination of the question under an industrial and scientific point of view,—as influencing the physical well-being of the working classes, giving increased perfection to the products of industry, and lending a valuable assistance to the learned in the pursuit of science.

Application of Drawing to the Arts of Industry.

As regards the application of drawing to the arts of industry, or those that minister to the supply of our physical wants, there is scarcely a common trade that does not present constantly recurring opportunities for its employment.

Artificers, such as builders, masons, carpenters, smiths, and a host of others whose business consists in the performance of works of construction, cannot, if they do not understand plans and drawings, execute correctly the orders which they receive; and the imperfect knowledge or total ignorance of many of them, in this respect, frequently causes mistakes or misapprehensions which are expensive and tedious to remedy.

Upholsterers, cabinet-makers, plasterers, and

decorators in other branches, too frequently learn, only after years of blundering, to understand (and that but imperfectly) the drawings and sketches in which the views of their employers are embodied. Machinists, millwrights, and ship-carpenters stand more highly in need of the assistance of drawings; as do also watchmakers, opticians, philosophical instrument makers, and others who have not only to superintend the construction of the most delicate instruments, but are likewise called upon, from the constant recurrence of new inventions, either to refer to the drawings of others, or to prepare drawings of details for the guidance of their assistants.

To those engaged in the pursuits of the civil or mechanical engineer, whether as principals or subordinates, drawing is a kind of indispensable language; and how many admirable inventions and useful contrivances may not have been left without a record, solely from the prevailing ignorance of that form of language. Invention itself is checked by the want of skill in the inventor to communicate by means of drawings the details of his combinations.

"Whoever has been accustomed to see the plans of houses and farm buildings, or of public buildings of an humble character in the country, must know the prevailing deficiency of our workmen in the art of drawing, where it is so closely connected with the comfort of domestic life, and is essential to the skilful performance of public works."

"In all those manufactures of which taste is a principal element, our neighbours, the French, are greatly our superiors, solely, we believe, because the eyes and hands of all classes are practised from a very early age in the arts of

design. . . . . Elementary schools for the cultivation of drawing exist in Paris, and in many of the chief towns of France; these schools are the sources of the taste and skill in the decorative arts, and in all manufactures of which taste is a prominent element, and which have made the designs for the calico-printers, the silk and ribbon looms, the papers, and similar works of art in France, so superior in taste to those of this country, notwithstanding the superiority of our manufactories in mechanical combinations*."

Advantage of Drawing in the Study of Science.

Again, if we consider the study or advancement of the physical and natural sciences, we find that drawing is an indispensable auxiliary to their cultivation.

Astronomy, geology, geography, anatomy, surgery, zoology, botany—in short, almost the entire range of the natural and experimental sciences require the constant aid of drawing.

Drawing a means of diffusing Scientific Knowledge.

In one of the most eloquent of modern works on science†, an earnest hope is expressed that the elements at least of the scientific knowledge which has been hitherto limited to a very narrow sphere, should be made accessible to all, "were it only that they may be more thoroughly examined into, and more effectually developed in their consequences,

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* Dr. Kay's *Report on Training School*, page 242.

† Sir J. F. W. Herschel's *Discourse on the Study of Natural Philosophy*.

and receive that ductility and plastic quality which the pressure of minds of all descriptions, constantly moulding them to their purposes, can alone bestow; there is no body of knowledge so complete, but that it may acquire accession, or so free from error, but that it may receive correction, in passing through the minds of millions." The acquiring and imparting of this knowledge, together with its probable additions and improvements, would be facilitated and hastened in a material degree, were drawing to lend its powerful aid. "If we consider *language* according to the design thereof, namely, apt signs for the communication of thoughts*," then can drawing fairly lay claim to that title. It is the language of form, and by it alone can exact ideas of the shape and size of objects be expressed. It offers moreover, this advantage, that it is intelligible to all and in all countries alike,—a universal language.

Drawing eminently useful to Teachers and Professors.

It would be tedious to enumerate with more detail the various branches of knowledge to which drawing must necessarily be applied, when it is desired to cultivate them with success; but we must not omit to point out the great benefits that all teachers and professors would derive from the possession of sufficient skill to draw with correctness and rapidity the figures referred to in their demonstrations. In teaching the elements of geometry,

* Holder.

there prevails an almost universal habit of neglecting precision in the figures, assuming them to be correct, and dwelling on the demonstration alone. This may offer a useful exercise to the advanced student; but, with a young beginner, figures drawn incorrectly tend to confuse and perplex him, in an operation of the mind which itself demands the full exercise of his undivided powers*. Also, when it is desired to illustrate the application of these abstract truths to practical purposes,—in mechanics, for example,—it is evident that lessons on the most simple subjects of that important branch of applied science must be wanting in demonstrative force, if the teacher is incapable of delineating the machines of which the lessons treat.

If, then, it be admitted, that drawing is of such universal application, it must appear singular that the general want of it has not been supplied, and that to this day comparatively few of the middle classes, and scarcely any artisans, possess a knowledge of drawing†.

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* We are well aware that geometrical truths are based on the conclusions of reason, independently of the exactness of diagrams; but practice in the exact delineation of these diagrams is as useful in geometry as the correct solution of exercises in arithmetic. It serves to impress the knowledge more efficiently on the mind of the young student, at the same time that it directs at once his attention to drawings of constructions, the chief use to which geometry, strictly so called, is applied.

† The annexed passage in LOCKE's *Thoughts on Education* shows the degree of importance attached to a knowledge of drawing by that distinguished philosopher :—

Drawing formerly cultivated among Artisans.

That this has not always been so, may be inferred both from historical records, and from the evidence furnished by the monuments of past ages.

Among the Greeks, drawing and design are said to have been cultivated, not merely by the artists who sent forth from their ranks the eminent men to whom the world remains indebted for those perfect models of architecture and statuary which modern genius has in vain essayed to surpass or equal, but also by the mass of the people, who by that cultivation became qualified to appreciate and reverence the productions of genius, the familiar observation of which gave additional refinement to their taste.

"When he (the pupil) can write well and quick, I think it may be convenient not only to continue the exercise of his hand in writing, but also to improve the use of it further in drawing, a thing very useful to gentlemen on several occasions, but especially if he travel, as that which helps a man often to express, in a few lines well put together, what a whole sheet of paper in writing would not be able to represent and make intelligible. How many buildings may a man see, how many machines and habits meet with, the ideas whereof would be easily retained and communicated by a little skill in drawing, which being committed to words, are in danger of being lost, or at best but ill retained in the most exact descriptions? I do not mean that I would have your son a perfect painter: to be that to any tolerable degree will require more time than a young gentleman can spare from his other improvements of greater moment; but so much insight into perspective, and skill in drawing, as will enable him to represent tolerably on paper anything he sees, may, I think, be got in a little time."

And that, in the middle ages, numbers of artificers must have understood the arts of drawing and sculpture, is made manifest (independently of historical records) by the religious monuments of that era that adorn all parts of Europe, and of which every district in England presents noble specimens. They offer to our admiration examples so numerous and wonderful of elaborate carving, and appropriate ornaments made subservient in their most minute detail to the essential parts of the construction, that we feel convinced that numbers of artificers, possessing a knowledge of drawing, must have lent their aid to execute with such fidelity the bold conceptions of the architects. This conclusion will be admitted by those who have experienced the difficulty of making even the foremen of masons or bricklayers understand the working drawings of very simple constructions.

Erroneous opinion that Drawing may not be learned by all.

A belief, nevertheless, obtains very generally, that drawing is an art difficult of acquirement, and one which can be cultivated successfully only by few. Without doubt, the higher branches of this art, as of all others, can only be cultivated to perfection by a small number of the most highly gifted; but correct drawing, and a facility in representing objects, or giving expression to ideas, may be acquired by all, and requires no genius*.

* From an unfortunate and false idea, it has been determined,

It is with drawing as with literary composition. Although but few have, in the course of ages, obtained pre-eminence by their productions, the art of writing, nevertheless, continues to be studied and practised by the mass. Unable to produce works fit to be compared with the master-pieces of those master-minds, they, nevertheless, succeed in expressing their thoughts correctly, thereby adding to the general fund of knowledge.

If we compare the elements of drawing with the elements of mechanical writing, (*i. e.*, the mere formation and combination of letters,) we shall find that they are, both alike, imitative arts. "Writing is a species of drawing; it represents forms and appearances in certain proportions and in a certain order," and he that can be taught to imitate the shapes of letters may likewise, by the adoption of a judicious method, be taught to imitate other forms; indeed, the complicated forms of letters in many languages present more serious obstacles than are met with in the rudiments of drawing.

Causes of the general want of a knowledge of Drawing.

We regret that there is some appearance of reason for the prevailing belief, that drawing pre-

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that a particular genius is necessary to drawing. Forgetting that it is proper for every one to see aright, (should they choose never to draw,) the principles of appearance are in general neglected, and the most useful, most common, and most delightful of the powers of sense is not enjoyed in its full extent.—Robson's *Grammar of Drawing*, page 17.

sents at every step so many difficulties that they cannot be overcome by the mass; a conclusion deduced naturally enough from the circumstance that so very few among the middle classes can represent correctly any simple natural object, although the greater number have received lessons in drawing. The fact that so many parents continue to have their children taught the art, although in the majority of instances the study seems to lead only to waste of time, may be taken as a proof of the sense they entertain of its usefulness. One cause for this general want we lament may certainly be ascribed to the fact, that the study of drawing is too long deferred; but, without losing sight of this element, we shall endeavour to demonstrate, that the chief reason for this contradiction between our proposition, that drawing may be learned by all, and the results of ordinary practice, exists in the insufficiency of the methods generally adopted.

Essential principles of sound method in elementary instruction.

The question of "method" is one of too high importance, and too extensive a bearing, to be examined in this place: we shall limit our observations to a statement of what are generally admitted to be essential principles in a right method of teaching the elements of any branch of knowledge, and examine whether the plans generally adopted for teaching drawing are in accordance with those principles.

In every method of instruction we trace three distinct processes: 1st, Analysis; 2nd, Classification; 3rd, Synthesis, or Construction.

The first and second of these processes, being the more difficult, should be effected by the teacher, under whose guidance the pupil should perform the third operation of construction.

In this, the more simple demonstrations should always precede the more complex, each lesson being a continuation of the previous one, and a preparation for that which succeeds it. In this arrangement the teacher will avoid presenting any serious difficulty at the outset, and treat the subject in such an order that, commencing with a very simple proposition, he shall lead the pupil onwards by a succession of increasing difficulties, so minute as to be almost imperceptible, but capable in the aggregate of carrying him, with unrelaxed attention and increasing conviction, to the most complex problems. "The chief art of learning is to attempt but little at a time; the widest excursions of the mind are made by short flights frequently repeated."

To fix the attention of the pupil, practice should invariably accompany theory; in other words, no rule ought to be deduced or taught without an early opportunity being afforded for its application. By due attention to this maxim, imitation or mere rote-work will be avoided; and when the faculties of imitation and memory are exercised, it will be in conjunction with those of perception and reflection; and the reason of the pupil will assist him, and his

judgment will be convinced, in the consideration of each new problem.

If attention to these general principles be essential to ensure success in a right method of instruction, we have next to examine whether the methods in general use for teaching drawing are based upon them.

Drawing from Copies.

In the first place we observe, that the pupil is almost universally made to draw from copies.

This fails to exercise the judgment. The drawings which serve as copies, exhibit a symmetrical disposition of lines in true perspective, as also varieties of tint and shadow duly laid and harmonized: they are imitated mechanically by the pupil without his understanding or reflecting upon the means whereby certain effects are produced. His hand alone is exercised; he fails to acquire a habit of observing and seeing correctly, and is unable, after years of labour spent in these purely mechanical exercises, to represent correctly the simplest natural objects. The Chinese cultivate the art of drawing according to this plan; they copy from copies, and produce fac-similes of any work of art; but this is performed solely as a piece of laborious imitation; and their signal failure, when they undertake to design original compositions, is the consequence of the faulty system which aims at training the hand alone to works of the highest skill. High finish in the drawing cannot compensate for glaring inaccu-

racies of perspective, and even the individual forms, although elaborately brought out, are devoid of expression, exhibiting labour and pains without intelligence, the consequence of following out details without comprehending the scope of the whole design, and of exercising the hand without the guidance of science and understanding.

Drawing from Copies a delusive kind of industry.

Sir Joshua Reynolds, in his Second Discourse, says, "I consider general copying as a delusive kind of industry; the student satisfies himself with the appearance of doing something; he falls into the dangerous habit of imitating without selecting, and labouring without a determinate object: as it requires no effort of the mind, he sleeps over his work; and those powers of invention and disposition, which ought particularly to be called out and put into action, lie torpid and lose their energy for want of exercise. How incapable of producing anything of their own those are who have spent most of their time in making finished copies, is an observation well known to all those who are conversant with our art."

Moreover, the drawings presented to the pupil as models, are not always perfect, having themselves probably been copied from other copies, which may also have been made without direct reference to nature. The drawings of all are more or less characterized by mannerism, and thus, a defect in the original imitation is imitated with care by the pupil, who

receives praise or blame according as he approaches to or departs from the peculiar style of the master's productions, whose preconceptions lead him to discourage in his pupil the cultivation of a touch or mode of execution at variance with his own.

Exclusive, therefore, of a certain mechanical facility of touch, the pupil acquires little real knowledge by drawing from copies. After years of study, he will be capable of making highly-finished fac-similes of engravings or drawings; and, if he be endowed with a retentive memory, he will have learned a set of unvarying conventional signs for the representation of natural objects in their numberless variations.

Drawing from Copies conveys no knowledge of the Laws of Perspective.

To draw from nature, or to produce a representation of actual things, being the aim of the majority of those who study the art, the pupil will, on leaving his master's care, endeavour to represent some familiar forms; but as he knows nothing of the laws which regulate the appearance of solid bodies, nor of the principles by the help of which these may be pourtrayed on a plane or curved surface, he will find himself compelled, in the representation of the more complex forms, to return to the conventional signs he has hitherto used for them, and will apply these indiscriminately, regardless at first of giving an unfaithful copy of nature. Each new attempt, however, will tend to impress him with a consciousness of his

defects; and, discouraged by the failure of his endeavours to remedy them, he will give up, then and for the remainder of his days, the further cultivation of drawing, satisfied with the reflection that he has no taste for its pursuit, and seldom thinking to call in question the supposed fitness of the method by which he has been taught.

This is the history of the majority of those who devote for several years, to the cultivation of drawing, a portion of their valuable time, thus misapplied and lost*.

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* "Freedom of execution, or masterly handling, as it is termed, is often taught to pupils, that they may appear to be making great strides in the art. The master frequently finds his pupil too dull, or too inattentive, to acquire a correct knowledge of his subject, therefore gives him the power of displaying an appearance of dexterity. To an uneducated eye, a sketch of a tree, for example, may be hit off by the pupil with sufficient resemblance to satisfy all parties; the parents see nothing in the original different from the copy, for that which appears to them but a scribbled appearance in the original indicates to the eye of an artist foliage, branch, and shadows; thus their education seems finished before it is in reality begun, and they leave school without the power of drawing a line. In after life, when they wish to delineate objects correctly, they find this dexterity rather an incumbrance; the eye, previously debauched, is incapable of receiving a true impression, while the hand, necessarily confined to the several spans allotted to the different forms, feels cramped and awkward, and obliges them to throw down the pencil in despair. In other branches of science we find this dexterity checked in its infancy. I remember an artist who always took an opportunity of disconcerting the pretensions of such precocious geniuses in drawing, by laying down a key, or a pair of snuffers, for them to delineate."—BURNET *on the Education of the Eye*, note, page 21.

Drawing from Nature inculcates habits of observation and of contemplation.

Had the pupil, on the contrary, been taught, from the very elements, never to attempt any delineation until he had carefully examined and ascertained the characteristic forms of the object to be represented, he could not fall into such errors. By degrees he would have acquired a habit of close observation and careful examination of objects at all times, which habit would tend greatly to promote his advancement as a draughtsman, although he might not be, when thus engaged, actually at work with the pencil*. With his knowledge thus increased by daily and habitual observation, his hand would lend itself readily to a representation giving the characteristic forms, which could not fail to be more pleasing to the eye of the intelligent observer, than the most elaborate production of mere manual dexterity†.

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* "Though a man cannot at all times, and in all places, paint or draw, yet the mind can prepare itself by laying in proper materials, at all times, and in all places."—Sir Joshua Reynolds' *Second Discourse.*

† "*Drawing much* improves as little as *reading much*, unless we contemplate and understand as we proceed; those who have acquired a readiness of hand without correctness and study, have but the shadow instead of the substance; and though to the unlearned their works have the appearance of excellence, yet to educated eyes they seem in the light of forgeries, or like the language of him who talks speciously of a subject he does not understand."—Burnet *on the Education of the Eye*, page 20.

Education of the Eye valuable to all.

Habits of observation thus cultivated are of great value, not to the draughtsman only, but to all.

"The common phrases, 'a quick eye,' 'an accurate eye,' can only mean an educated eye, for every eye in a healthy state is quick and accurate. It is the understanding that is slow and imperfect—imperfect, because it does not take the time and pains requisite completely to comprehend the characteristic features of the image formed on the retina*. Upon the degree of attention bestowed on these evanescent pictures depend the perfectness and durability of the ideas of external things with which the memory is stored, the understanding enriched, and the fancy enlivened. The intellectual operation in this case may be likened to the chemical process by which photographic pictures are rendered permanent; it is this which resolves the fleeting visions of the outward sense into distinct and lasting ideas of the mind. In default of this mental process, too many of our fellow-creatures go through life almost insensible to the sources of enjoyment continually presented to them; having eyes, they see not, or, 'seeing, they see, and do not perceive:' 'their eyes are open, but their sense is shut.' The image painted on the retina of the merest dolt that ever gazed on a beautiful prospect is as vivid as that presented to the painter, or the poet; the intellectual comprehension and appropriation make the difference. Hence it is evident that vividness and correctness of perception depend upon the

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* "But I must premise, that it is an essential requisite, before proceeding to delineate any object, that we make ourselves thoroughly acquainted with its general character, otherwise the eye cannot convey to us its image distinctly, neither can the hand render it with energy and precision."—Burnet *on the Education of the Eye*, page 15.

understanding; and the training or education of the eye, means the discipline of the mind in relation to ocular perceptions*."

Knowledge of Form, and of the Laws of Perspective, essential.

The first desideratum for correct drawing is a knowledge of the form intended to be drawn, which should precede the attempt at its delineation. Conjointly with this, the pupil should have a clear conception of the effects of perspective in changing the apparent forms of objects, as also a knowledge of the principles by which the appearance of solid bodies may be represented on a plane or curved surface: both perceptions are clearly the results of operations of the mind. Drawing, therefore, considered simply as the representation of form, is not, strictly speaking, an art, but a branch of science, the practice of which is as much the result of an exercise of judgment and reason as the practice of the science of numbers, or the consideration of the properties of space. He, therefore, who can learn arithmetic, or geometry, is likewise capable of acquiring a knowledge of drawing.

Of perspective the student has learned nothing, when drawing from copies. Those who have studied geometry at the same time with drawing, may have been shown some applications of linear perspective,

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* *Elements of Perspective Drawing*, page 5. Taylor and Walton.

but treated in a manner so entirely unconnected with drawing from nature, or with representing actual things, that the two sciences have no common point of union.

Perspective, as an abstract science, unsuited for popular or elementary instruction.

The principles and strict rules of perspective are in reality a part of geometry, and, if considered in their most extensive application, they form an advanced branch of the science, embracing the geometry of plane and curved surfaces. But the possession of this branch of knowledge is far from general, and consequently Treatises on Perspective, designed for general and popular use, omit strict mathematical demonstration; and, abandoning the purpose of convincing the judgment, supply merely a collection of examples to be referred to as a dictionary; and of rules to be learned by rote, without a knowledge of the principles from which these rules have been deduced, and by reference to which each problem is to be solved. By means of such rules, the student learns to place in perspective certain geometrical figures, with certain data, consisting of, and defined as, the ground plan, the perspective plane, the principal distance, the principal point, the directing plane, &c.; but as he sees all these planes, or their intersections, projected in arbitrary positions on a flat surface, he cannot, unless possessed of a knowledge of the geometry of planes, form a correct idea of the actual points, planes, or distances

they are intended to represent: the terms convey no precise ideas to his mind.

Strict Rules of Perspective inapplicable to the practice of Drawing from Nature.

Even if in treatises designed for general use on perspective, viewed as an abstract science, it were possible to overcome the difficulty arising from the rare possession of a sufficient knowledge of geometry, little would be gained towards facilitating the drawing of actual forms; for the operations required to determine geometrically the "accidental" vanishing points in forms very far from complex are so laborious, that they are rarely, if ever, resorted to by artists.

Perspective may be taught without the intervention of strict Mathematical Investigations.

The proper course seems to be, therefore, to establish and demonstrate to the student's satisfaction the essential rules of perspective, not by the intervention of strict mathematical investigations, which are unsuited to the general state of knowledge, and especially to the intelligence of children and young persons, for whose benefit it is intended to introduce a system of drawing into elementary schools; but, by substituting for the mathematical investigations, deductions reasoned out of appearances that are manifest to all, to establish correct and general rules which shall serve as guides, and admit of direct and immediate application to practice.

In the same way that habit and experience enable us to judge without effort of the real forms of objects, although perspective alters the appearance of those forms; in the same manner the habitual practice of perspective drawing from natural objects, under the guidance of the judgment and understanding, enables the pupil to appreciate at a glance, and almost intuitively, the proper directions and requisite amount of foreshortening to be given to the lines on the surface of the drawing. It is in this way, in fact, that all artists place objects in perspective: they never think of referring to geometrical figures, nor of tracing the multiplicity of lines, which, on opening treatises on the subject, we find as apparently requisite for placing even the simplest forms in perspective.

Instance of the labour required to finish a Drawing by the Rules of Mathematical Perspective.

That perspective, applied with mathematical truth, is unsuited to the general wants of the artist is made manifest, when we reflect that a plan and several elevations of an object to be placed in mathematical perspective, as also the position of the observer with reference to the object to be delineated, are necessary data. For example, if an artist wished to make, with mathematical accuracy, a perspective representation of a house viewed sideways, he would have, before commencing his drawing, to measure his distance from the building, to ascertain his elevation with reference to the base, and to deter-

mine its ground plan, as also the front and lateral elevations. But as so laborious a process is, of course, inapplicable to the object in view, the artist is satisfied with applying his knowledge of the general principles of perspective to guard against errors in the delineation which he performs by an approximate process in which his trained eye is the guide. Nor is greater precision requisite than that obtained as the result of his practical skill; for, had it been possible to perform the work with mathematical accuracy, the eye could not appreciate the difference between the truth and the skilful approximation.

Exceptional Cases.

There are cases, however, (those, for example, of an architect, or an engineer, designing for a proposed construction,) in which the designer has the means of placing in correct mathematical perspective, and with little trouble, the general outline of the ideal form which he has conceived, because he possesses the necessary data of plans and elevations, the execution of which is an essential part of his work of designing. For such an object more than an approximation is required; but such a want is rare, because, for the purpose of actual construction and for the use of the workmen or others to whom the execution of work is entrusted, a perspective drawing is useless, and simple geometrical plans and elevations are alone required.

The essential acquirements, therefore, to the

artist, and to all who are desirous of drawing from actual forms, are a knowledge of the general principles of perspective to guide in observing nature as well as in performing the delineation, and the acquisition, by assiduous exercise in drawing from actual forms, of that talent which may be called the perspective of feeling or of the eye*.

In this Manual perspective is consequently treated as an essential part of drawing, as its very grammar; and being based on general principles, admitted as universal truths, it is treated in such a manner as to be intelligible to all. To this end it

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* It is not intended, by the preceding remarks, to imply that a mathematical knowledge of perspective is not eminently useful to the artist, or draughtsman. Such knowledge, on the contrary, gives him a more precise idea of those effects which it is so important to appreciate correctly, in order to produce a faithful representation of nature; and in accordance with this view we have given at the end of the Course the mathematical investigation of the general or fundamental theorem of perspective. But that which we would avoid is the teaching, *by rote*, the rules obtained from mathematical investigations, to children or others who, not being possessed of geometrical knowledge, are therefore unable to perceive the truth of the rules, or even to understand the meaning of the points, lines, or planes, referred to in those rules. Such rote-work is in itself sufficiently objectionable, but to strengthen our view of the inexpediency of resorting to it, we show that the strict rules are themselves inapplicable (with a few exceptions) to the practice of drawing from nature, for which exercise a knowledge of the general principles of perspective is alone required; and these may be taught to children or others not possessed of geometrical knowledge, not by rote, but by the aid of the judgment and the understanding.

has been divested of artificial difficulties, and stripped of all such technicalities as tend to place it in the light, either of an abstract science or of a craft or a mystery.

"Arts and sciences, like everything else, have of course their own peculiar terms, and, so to speak, their idioms of language; and these it would be unwise, were it even possible, to relinquish; but everything that tends to clothe them in a strange and repulsive garb, and especially everything that, to keep up an appearance of superiority in their professors over the rest of mankind, assumes an unnecessary guise of profundity and obscurity, should be sacrificed without mercy. Their whole processes should be laid open, and their language simplified and rendered universally intelligible*."

Too frequent departure from the Synthetic Method.

Another cause of failure in the methods too generally adopted hitherto, has been the departure from the synthetic or constructive succession of exercises, the teachers omitting the analysis and classification which should provide for the pupil the easier task of advancing step by step from the simple to the complex. It is not assumed here that teachers of drawing have been altogether regardless of this principle; for, since the publication, in the fifteenth century, of Leonardo da Vinci's *Treatise on the Art of Painting*, wherein he recommends an adherence to the synthetic method, all have endea-

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* Sir J. F. W. Herschel's *Discourse on the Study of Natural Philosophy*, page 70.

voured to some extent to act upon it; but the principle itself has been strangely misunderstood, and, as regards drawing at least, it has been imagined that a mere separation, or, as it were, a cutting up of a whole into parts, constituted a true and proper analysis. For example, when the student is taught to copy drawings of the human figure, it is conceived that the complex forms of the figure are analyzed for the pupil and simplified, when he is given to draw each feature separately, and he is therefore made to commence with an eye, an ear, a mouth, &c., first in outline, then shaded, but the feature in each case being perfect. Now such a process is merely separating the figure into parts, and not performing a proper analysis, whose object ought to be to present to the beginner the simplest elements of forms, to be succeeded by others gradually becoming more and more complex and difficult. This, the true object of the preparatory analysis to be performed by the teacher with the view to lighten at first the difficulties for the beginner, is certainly not accomplished with reference to the human figure, by presenting each feature perfect in itself. In the first place, an eye or a mouth, if it is to be so drawn, as to mean anything, is nearly as difficult as the *ensemble* of a head; in the second place, there is no mark of progress or increasing difficulty characteristic of the synthetic method in making the learner pass from an eye to a nose, then to the mouth, then to the ear. It is possible, on the contrary, that the first may be more difficult than the last.

Attention at first too exclusively directed to Details.

Supposing, however, that the beginner has overcome the difficulties and struggled through the tediousness of the first steps, and that he is able to draw each of these features with a most elaborate finish and careful attention to the minutest details, he is next required to group them together. But here he fails, until he has bestowed much time and labour in endeavouring to get rid of the habit of engrossing his attention with details. The teacher, to the student's astonishment, now changes his system, and, desiring him not to pay much attention to the details, tells him to enlarge his views and conceptions, and even to risk errors in the minutiæ for the sake of a correct *ensemble.* But this is a contradiction to the first precepts and exercises, and the pupil cannot at once lose the habit previously encouraged of aiming at mechanical perfection in the details. "The tyranny of schools commences when any unreasonable effort is required. In this way is repressed that earnestness which characterizes the early efforts of youth: its generous spirit can only be cherished by leading it from one truth to another, and not from one contradiction to another*."

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* *Minutes of the Committee of Council on Education*, 1840-41, page 37.

Drawing at once from Life, proposed by some as a Substitute for Drawing from Copies.

In the middle of the last century, an eloquent writer* raised his powerful voice against the vicious system of drawing from copies, but he himself failed in the remedy he proposed, by neglecting the important consideration of preparing for the gradual progress of the student by a judicious analysis.

His recommendation was to the effect, first, that the child should, in all cases, be made to draw from a natural object, and that he should not receive permission to draw from memory, until he had, by repeated exercises and observation, completely imbued his mind with a perfect knowledge of the forms and appearances of the objects he might desire to pourtray. Without this last precaution, there would be a risk that, by a frequent substitution of grotesque and fantastic shapes for the true forms, he might so vitiate his taste, as to rest satisfied with a series of conventional signs without feeling the want of more correct representations. So far the principle was excellent, but the method proposed for carrying it out in practice was injudicious: the child was to commence with drawing the human figure from life.

In Mulhauser's excellent method of teaching writing, we find the author availing himself of the natural tendency of all children to imitate objects,

* ROUSSEAU.

and to do what they see others doing, and moulding that natural impulse to the purpose in view. At the child's own request, he gives him a pencil and paper, and leaves him to himself in his first attempt at shaping forth letters. The child, dissatisfied with the glaring failures of his work, asks for instruction, and desires to ascertain wherein the faults consist: the teacher takes advantage of his curiosity to explain to him, by separate demonstrations, the several conditions required to constitute good writing, points out wherein he has failed, and convinces him that to attempt at first to copy an entire sentence is too difficult. The child, still anxious to learn, is then given a very simple exercise, one of the elements of a letter, and is pleased with his success. Here allowing the child to attempt to copy at first entire sentences, is merely with the view to stimulate his interest; and afterwards, when he is made to begin with shapes that do not singly constitute letters, to satisfy his judgment, by pointing to the ultimate tendency of his efforts.

System of Drawing at once from Life considered.

Now in proposing, as was said above, that the child should commence with drawing from life, the author acknowledges that he will at first, and for many months, produce most absurd shapes, probably (as we have seen with all children) a single line for each limb, fingers thicker than the arm, and hands larger than the body. Gradually the absurdities of these proportions would

manifest themselves even to the child: it would by degrees become apparent even to him that the body has a certain breadth and thickness, greater, undoubtedly, than that of the hand; that this breadth is not in every part the same; that the arm has a certain determinate length proportionate to that of the body; and so on with the other parts and dimensions of the entire figure. And, adds the author, the child, when endeavouring to correct the false proportions in his drawing, could not fail to improve his powers of observation and comparison, and thus to acquire a knowledge of the true forms. The object sought, namely the cultivation of the judgment and understanding, is good; but when the child, after repeated and vain attempts, should find his performance far, very far, from the truth, he would become discouraged, and give up the pursuit in despair.

Similar proposition to Draw at once from Antique Statues.

The proposition bore within itself the elements of failure; it was therefore not acted upon, except in a few isolated instances, until it was revived with a slight modification by a distinguished advocate of the analytic method in education, M. Jacotot, who established schools in which the pupils were taught from the very beginning to draw from statues of the antique. The error here is the same, that of presenting to the learner to copy, forms which have defied the genius of modern art to imitate. In the same way might it be attempted to teach geometry

to a child, by commencing with the complicated problems of transcendental analysis. Why is it that the most ancient work on elementary geometry continues, after the lapse of twenty centuries, almost unchanged, to serve as the text-book or manual for all who enter on the study of the mathematical sciences, but chiefly because of the judicious arrangement so happily contrived for the purpose of instruction, of proceeding step by step from simple to complex*?

A similar process must be followed with respect to drawing, if it be desired to make it a general acquirement.

Proposal to Draw at first from Simple Geometrical Forms.

Lacroix† was the first to suggest an enlightened method of imparting the knowledge of drawing,—one equally free from the defect of drawing from copies, and from the error of neglecting a judicious analysis‡. Inanimate objects, such as instruments

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* There are, no doubt, imperfections in the *Elements of Euclid;* and when they are referred to as an example of synthetic arrangement, each book is considered, *per se*, as a separate treatise in itself. The high place which the work, notwithstanding some acknowledged imperfections, has continued to hold for so many centuries, is evidence of the success which must attend the synthetic method of teaching, when applied to the elements of science.

† *Essais sur l'Enseignement*, page 320.

‡ The idea of drawing from models did not originate with Lacroix, for the manifest failure of the method of teaching from copies suggested the adoption of models, previously to the publi-

of art, machines, details of construction, chemical and philosophical apparatus, or other objects of general utility, will be found to be composed of regular geometrical forms, or may be referred to them; and even the varied forms which occur throughout animate nature have for their component elements geometrical figures. With the representation of geometrical forms, therefore, the pupils should be made to begin; and among these some may be chosen of so simple a character, that the pupil can copy them without serious difficulty.

Advantages of this Method considered.

An important advantage to be derived from commencing with forms thus bounded by well-defined lines is, that the precision of the outline admits of the pupil being convinced to demonstration when he has committed an error, and of his correcting his error himself when it has been indicated to him.

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cation of his essay. The system, however, was ill digested, and imperfectly matured, until Lacroix, in a few sentences, sketched its proper principles with his customary clearness. In this country and in Scotland, as well as on the Continent, models have been used by a few teachers for nearly half a century, and of late years their use has been much extended, so much so as to demonstrate that many are now prepared for the adoption of a more systematic and judicious method than that of drawing from copies. M. Dupuis, an eminent professor in Paris, was the first to use models on an extensive scale for teaching in classes.

This is most important, as mere dogmatical teaching or correction is thereby avoided.

Commencing thus with copying from actual objects, immediate opportunities are afforded of demonstrating the rules by which their apparent forms are modified and combined when it is sought to represent them on a surface.

The learner is required to become proficient in drawing the outline of geometrical figures and solids before he commences shading; for, alluring as coloured or shaded drawings may be to the eye, colour or shade are subordinate to correct outline, and no defect can be more serious than vagueness and inaccuracy of form.

The outline exercises are drawn of the full size of the originals, with white chalk on a slate*, in order to give freedom to the hand by the largeness of the dimensions, and to prevent the contracting of habits of timidity and hesitation, which must more or less be acquired by a beginner, who, when drawing on paper, finds that he cannot efface and correct the errors. This, conjoined with the simplicity of form in the first models, which does not distract the learner's attention by the prominence of details, contributes to train him to give preference to breadth and unity of effect, which deservedly rank as elements most con-

* The superior economy of thus teaching the first rudiments, which, if drawn on paper, lead to so much waste, is also a recommendation in a system that is proposed for introduction into elementary schools.

ducive to truth and beauty of representation*. The contrary tendency to this, the separation of the representation into many salient and unconnected parts, gives an appearance of spottiness, and destroys all grandeur and harmony.

An incidental but valuable benefit ensues from the pupil's attention being directed to, and his mind made to consider the properties of simple geometrical forms. A relish for their beauty and elegance is imperceptibly acquired, and the pupil is thereby guarded from the acquisition of a taste for paltry and meretricious ornaments, which are found to allure in the inverse ratio of mental cultivation; the ignorant and uneducated deriving but little pleasure from the contemplation of objects bounded by severe and simple outlines.

The method also, by cultivating the judgment, and rendering it immaterial from what point of view the model to be drawn is seen, lends itself readily to the simultaneous and systematic tuition of large numbers of pupils, who can themselves detect by reflection, and correct, with slight assistance from the teacher, the errors they may commit. And it is

* "The highest finishing is labour in vain, unless at the same time there be preserved a breadth of light and shadow; it is a quality, therefore, that is more frequently recommended to students, and insisted upon, than any other whatever: and, perhaps, for this reason, because it is most apt to be neglected, the attention of the artist being so often entirely absorbed in the detail."—Sir Joshua Reynolds, *Notes on the Art of Painting*, note 40.

only by means of a method capable of being thus applied to simultaneous instruction, that drawing can become a branch of elementary education.

This Treatise chiefly designed for the use of Teachers.

The object in view being that drawing may be taught as universally as the other elements of knowledge admitted into national and parochial schools, this Manual has been prepared for the use of teachers of elementary schools. It would be injudicious to place it at first in the hands of children, without the assistance of the teacher to explain away apparent difficulties, or at least without the models to serve in illustration of each proposition. In order to obtain the advantage of a uniform system, it became necessary to illustrate by diagrams, and explain by technical enunciations addressed solely to the teacher, the various positions to be given to the models; but these diagrams, resembling from their very simplicity geometrical figures, might lead the child or superficial observer erroneously to imagine that the subject embraced the consideration of abstract science. The theoretical enunciations, viewed in the Manual separately from the practical illustrations which are intended to be given at the same time, would not convey precise ideas to the inexperienced pupil, however quick he might be in point of general intelligence. In the perusal of a precept, the child, deceived by the apparent mystery of didactic language, would convert the easiest operation into a difficult problem; or, misled by the

timidity of inexperience, would seek for a profound meaning in an enunciation made in precise terms of a simple problem. If, on the contrary, ocular demonstration, theoretical deduction, and practical exercise, are employed simultaneously, the simplicity of the propositions is made manifest to the pupil, who becomes familiarized with the facts and the rules at the same moment; while the necessity for a frequent application of the same general rules, under slightly varying circumstances, in each succeeding exercise, impresses them on the memory, and after some practice renders them as familiar to him as his most common perceptions.

Having explained that this Course of Drawing is designed chiefly for the use of teachers, we would further observe, with reference to the style and logical arrangement, that, as regards the first, we have not sought to avoid the repetition of technical terms when it seemed that the meaning could thereby be made more precise; and that, as regards the logical arrangement, the continuity of the demonstrations of various optical laws is interrupted for the sake of enabling the pupil to apply to practice the rules or principles as soon as they have been demonstrated. To remedy, however, to some extent, this break in the continuity of the demonstrations, the interposed directions for the teacher have been printed in smaller type, and may therefore be passed over by those who would be desirous to embrace in logical sequence the consideration of the laws of perspective investigated in this Manual.

The mathematical investigation of the rules of perspective has been given at the end of the Course, in order that those pupils who possess a sufficient knowledge of the elements of geometry may trace the agreement between the general rules deduced in the Manual itself from common sense reasoning, and those obtained as the result of strict mathematical investigation.

This Elementary Course does not aim at the formation of Artists.

This Manual, let it be understood, is not directed to the formation of artists. Although the method it explains is thought to form the proper ground-work for further special studies in the art, yet it cannot of course be deemed desirable that all should aim at becoming artists. The principal object of this treatise is to diffuse a method calculated efficiently to educate the eye, to exercise the judgment, and to train the hand to skill in the representation of form. When the student shall have advanced so far in this course, as to have obtained a knowledge of the various causes operating upon lines so as to change their appearance to the eye, "let him then look abroad upon natural objects, and contemplate the various changes produced in their forms by their situation, so that his eye may become familiar with those alterations in form, and his mind enriched by a variety of examples; thus making nature furnish him with a thousand diagrams, which he ought to draw and write down his remarks upon; he will by

this method not only educate his eye, but improve his mind at the same time; the study of drawing being intimately connected with observation and reflection*."

Before concluding these general observations, we would say emphatically that this system is not set forth as a "royal road" to the science of drawing: it claims the merit of producing a more rapid progress in the study, and offers facilities of acquirement to all—but of this, all may rest assured, that no portion of sound knowledge is ever acquired without some corresponding exertion, and "excellence is never granted to man but as the reward of labour."

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* Burnet *on the Education of the Eye*, page 15.

The Teacher is here referred to Chapter XVI. at the end of the work, in which minute Directions are given and General Arrangements explained, with the view to facilitate the conducting of the Drawing Classes. Those Directions will, it is believed, be of great assistance to the Teacher when introducing the Method into his school; but as they are not necessary to the general reader, who may be only solicitous of acquiring a knowledge of Perspective, and of applying the Method without teaching it, the Chapter containing those Directions has been placed at the end of the book, so as not to interrupt the logical sequence of the various parts of the Manual, by introducing it in this place.

The Teacher will also, before proceeding with the demonstrations which follow, make himself master of the application of the eye-model and stand, and the mode of using the demonstration wire, with the threads attached. The explanation of Plate 1, page 253, describes the manner in which the different parts of the instrument are fitted together for use.

Chapter II.

PRINCIPLES OF PERSPECTIVE.

Styles of Drawing.

The different styles of drawing or design may be classed under the three following heads:—

1. The exact representation of natural objects, or artificial forms, with all the characteristics of each individual model or object.

2. The selection of individual forms or objects for the purpose of combining them together in an order different from that in which they are presented to our view: this is composition.

3. The selection and judicious combination of different compatible perfections never found united in a single object or model.

As the first business of the student is to be able to give a true representation of whatever object presents itself, just as it appears to the eye, this elementary course of drawing is intended to apply solely to the first of these styles, aiming at rendering the pupil competent to draw any object of fixed form, and imparting to him that exact knowledge which is the proper groundwork for future progress in the higher walks of the art*.

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* Sir Joshua Reynolds, in his *Second Discourse*, divides the study of his art into three distinct periods. In the first of these,

Solid Forms to be represented on a Surface.

All real things or objects have three dimensions, namely, length, breadth, and thickness; yet these three dimensions are to be represented by a drawing made on a *surface* (usually a flat surface), so that it may convey to the eye as nearly as possible the same appearance as that of the object itself.

Before we can draw successfully, therefore, we must have some knowledge of the laws that regulate the appearance of objects;—we must understand how objects are seen by us. So familiar is the exercise of our sense of vision, and so unconnected with the will are the results of its action, that many do not reflect on the laws which regulate these effects, and seldom seek to discover the relation between the forms and appearances of objects. With this investigation, however, as the basis of all correct drawing, it is necessary to commence.

Appearances of Objects vary with Change of Position.

The appearance of one and the same object is not always the same; its appearance, or the image

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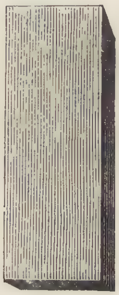
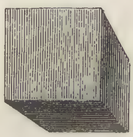
which is confined to the rudiments, he includes a facility of drawing any object that presents itself;—and, in another place, when dwelling on the necessity on the part of the student to draw with exactness from the models placed before him, he says, "I very much doubt whether a habit of drawing correctly what we see will not give a proportionable power of drawing correctly what we imagine."

which it presents to the eye, varies with every change of position. We all know, for example, that the front view of a face is very different from its side view or profile: the face itself remains unaltered; it undergoes no change; nevertheless, by a change in position, a great change takes place in its appearance.

In the same manner this model or book, held upright before the class, appears to have the height



greater than the width. By changing its position the width appears as great as, or greater than, the height.



Distinction between a Geometrical and a Perspective Representation.

It being thus shown that an object has one form only, but a variety of appearances, terms are applied to distinguish the representations of the real, from those of the apparent form. The first is called

a *geometrical* representation, the second a *perspective* representation.

Geometrical Representations.

In geometrical representations, such as the above, the eye is supposed to be opposite to,

Perspective Representation.

and at an equal distance from, every point of a surface to be drawn, each part being made of its true proportion. In a perspective representation, such as the annexed, the eye may occupy *any one* position whatsoever with reference to the object to be drawn; but the position, such as it may be, being once chosen, is supposed to be fixed, and the parts are then to be drawn, not in their true proportion, or of their exact form, but as they would appear when viewed from that fixed point. It is this latter kind of representation that we are to consider and examine in the following illustrations and exercises.

As we thus find that the very same object appears differently in different positions, although its actual form remains the same, it is evident that a knowledge of the form of an object is not sufficient to enable us to represent its appearance; and that we must also know the reason of such changes of appearances, and the laws or rules which regulate those changes, in order to represent the object correctly from any point of view.

Objects, how seen: Rays of Light proceed in every Direction.

Objects appear, or are seen by means of rays of light: in other words, that particular thing whereby we are enabled to see objects is known by the name of rays of light. These rays of light proceed from every point of the surface of a visible object, and in every direction. Wherever a spectator is placed with reference to an object, every point of that part

of the surface which is turned towards him is visible. Each and all the members of the class are able to see this model*, the walls of the room, the desks,—in short, any of the objects around, by means only of those rays of light.

Rays of Light proceed from every part of a Visible Surface.

If those rays of light did not proceed from *every part* of the surface of this model next to the class, that particular part of the surface from which the rays did not proceed would be invisible. Also, if the rays of light did not proceed from the same surface of the model in *every direction*, that surface of the model next the class would not be seen by all,—it would be seen only by a few. But this is not the case; all the members of the class see this face of the model, and if I move it from one side of the room to the other, they continue to see the same face to which their attention is directed. We conclude, therefore, that rays of light proceed in *every direction*, and from *every part* of the surface of a visible object.

Rays of Light proceed in Straight Lines.

These rays of light proceed in *straight lines*, and in straight lines only. Were it not so, you could see

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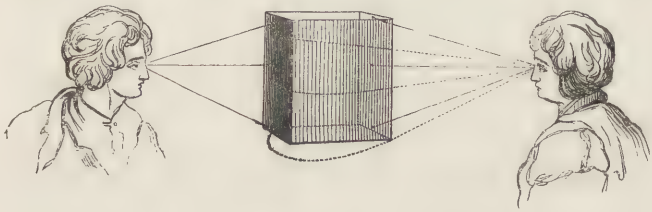
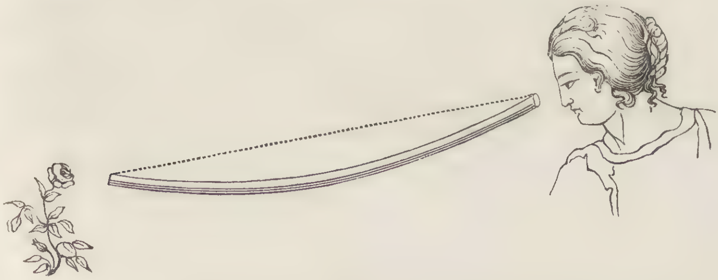
* The teacher here places the cube, or any other simple model, before the class.

the back of this model as well as its front. For the back of the non-transparent model is visible; I can see it when placed behind it: you cannot see it because the rays of light from it proceed only in straight lines. In order that you should see it, it would be necessary that the rays of light which



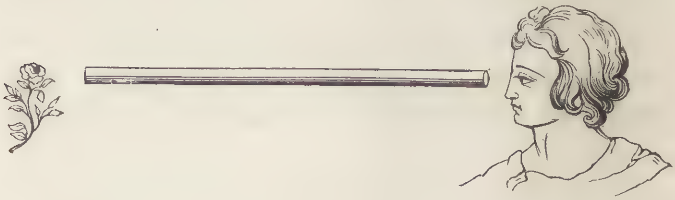
proceed from it should bend or turn round in their course to reach your eyes.

The progress of rays of light in straight lines is made manifest, by admitting the light of the sun into a dark room through a small aperture or narrow slit; if there be dust or smoke in the room, the straightness of the rays of light will be made apparent. Also, if we look through a continuous tube



considerably bent, we cannot see any object placed near the end of the tube; if we straighten the tube,

we are then enabled to see the object which before was invisible or hid from our view.



From the above considerations, we deduce the following proposition, namely:—

Objects are seen by means of rays of light that proceed in straight lines, in every direction, from every point of the visible surfaces.

Of these innumerable rays of light, some meet at the eye* of each spectator, and there form the images of the objects.

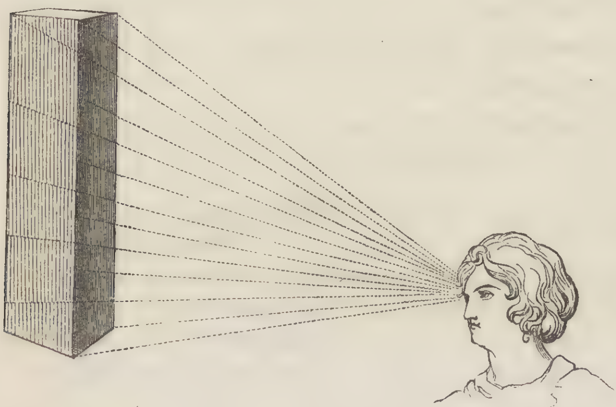
* Throughout the work rays of light are described as meeting at *the eye* of the spectator. The consideration of the question, why only one image of an object is seen with two eyes, is of a physiological and metaphysical nature, and therefore claims no place in this Treatise, which is intended for practical application. The fact that, under ordinary circumstances, only one image is seen, is sufficient for our purpose.

Chapter III.

PRINCIPLES OF PERSPECTIVE.

Analysis of the Direction of Rays of Light proceeding to the Eye.

We shall next trace the directions of these rays of light, and ascertain their relative positions, in order that, having learned how the image of an object is conveyed to the eye, we may be enabled to reproduce that image by a drawing. But if we endeavour in the first instance to obtain that knowledge with regard to this model, for instance,



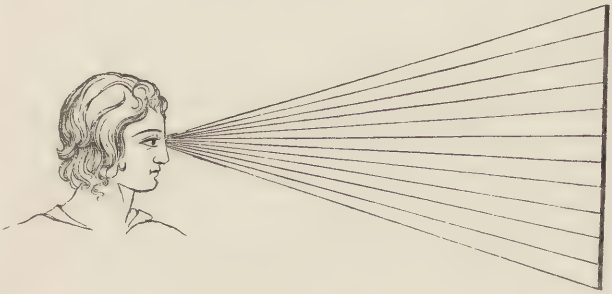
although the form of the model is simple, yet the lines which bound it are of varied lengths and directions, and by considering them all at once we should find it difficult to trace the course of the

rays of light that proceed from each bounding line. It will be simpler to separate, as it were, the straight lines which form the outline of the model, or determine its shape, and to consider the course and progress of the rays of light proceeding from a single straight line, which may be afterwards combined with others to reproduce the form of this or similar models*. Also, if we endeavoured to trace the course of the rays of light as they proceed from every part of a straight line to the eye of *each* member of the class, we should be confused by the great number of rays, as well as the varied directions, which we should have to examine. But it is needless to encounter this difficulty, for if we determine the laws which regulate the course of the rays of light as they proceed to the eye of one individual we shall have obtained the knowledge we require, because the aim of drawing is to represent the object as it appears to each one individually.

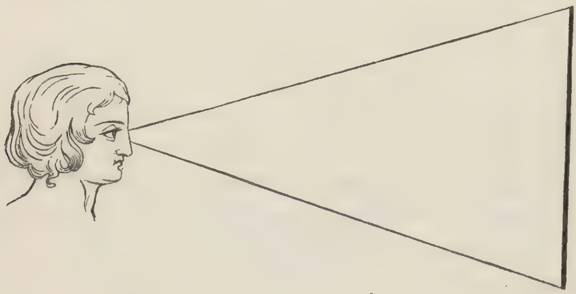
Let us therefore examine the course of the rays of light, as they would proceed from this straight line

* It may be thought that, by thus considering the properties of lines, we are dealing with abstract ideas which have no reference to actual things. This is not the case, for although lines cannot be conceived independently of the forms or bodies to which they belong, they have for the draughtsman a real existence; for whatsoever thing we examine we shall find that it is limited or bounded by surfaces, which surfaces have themselves lines for their limits or boundaries, and it is only by means of these bounding lines that we acquire the knowledge of the form or dimension of bodies, and that we can commence their delineation.

to the eye of one individual. Now, the rays of light conveying to the eye the image of this straight line proceed from every point of it, and may be said to



be innumerable. In endeavouring, therefore, to represent them by these straight threads passing from the right line to the supposed eye, we can make no approximation to their number. But even here we can simplify the illustration by omitting all the threads except those which proceed from the ends of the line. For if the ends or the extreme

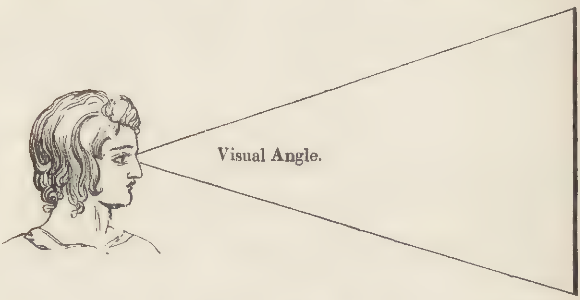


points of a straight line be fixed in position; if their distance asunder as well as relative position be known, the line itself, that is, its length and direc-

tion, are known. To find therefore the way in which the image of this straight line is formed at the eye, it will be sufficient to consider the rays of light that proceed from its extremities to the eye.

Of the Visual Angle.

On examining this model, which serves as an illustration, and in which the threads represent the rays of light meeting at the eye, we see that the

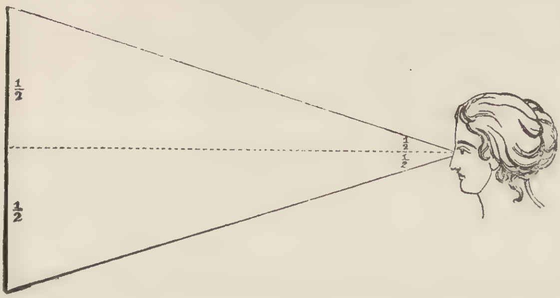


threads form at the eye an angle. This, the angle formed by two rays of light meeting at the eye, is called the angle of sight, or *visual angle.*

All other things being the same, the size of the visual angle (represented by the meeting of the threads in our illustration,) varies nearly* according

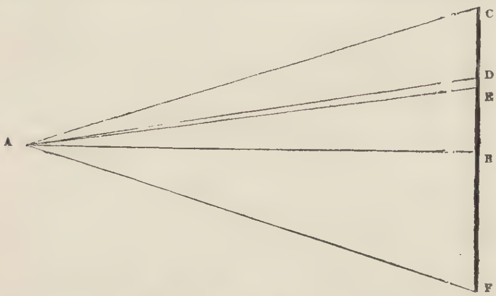
* In the diagram given in the text, in which the bisecting line has been drawn at right angles to the line that subtends the visual angle, the ratio of variation is the same for the angle and for the line. But the geometrician will perceive that this ratio is mathematieally true only in those cases in which equal lines are on opposite sides of the axis of vision, and at equal distances from it. In all other cases the angles vary in a ratio slightly different from that of the lines.

Let A B, a line representing the axis of vision, meet the line



to the size of the object, or the length of the line from which the rays proceed, increasing or diminishing according as the object is larger or smaller. In this example I diminish the visual angle one-half, if I shorten the line one-half.

F C at right angles at B, and let B C be bisected in D; join D A. The angles C A D, D A B, are unequal, although subtended by the

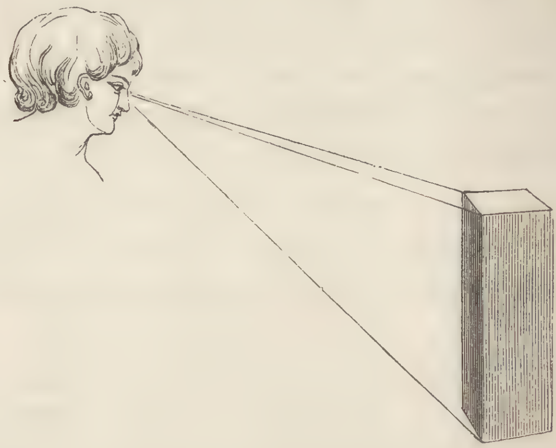


equal lines C D, D B. For, let the angle B A C be bisected by the line A E, meeting B C in E, then the segments C E, E B, shall have the ratio which the sides A C, A B, have to one another. (Euc. 3. VI.) But A C is greater than A B (Euc. 27. I.), therefore C E is greater than E B, but as C E and E B subtend equal angles at A, C D and D B must subtend unequal angles.

However, for practical application to Perspective Drawing, and especially in cases where the visual angles are small, the ratio of variation, as given in the text, may be assumed to be correct.

Relative Magnitude estimated by the Size of the Visual Angle.

This at once accounts for our being able to ascertain (without measuring or touching this model,) that its height is greater than its width. All perceive this to be the fact, and as it is only by means of



the rays of light that they acquire the knowledge of this relation, we must find in the course or relation of the rays of light the means of accounting for this effect. The foregoing illustration has solved the problem, and accounted for the effect, by showing that the *longer* line, that is, the height of the model, forms at the eye a *larger* angle than the shorter line, that is, the width of the model.

The rays of light passing from the extremities of a line, or from the angular points of an object to the eye, may therefore be compared to the legs of

a pair of compasses, which are made to open more or less according as the object to be spanned by them is larger or smaller. In the same manner that, by spanning with a pair of compasses the height and the width of this model, we could find that the first dimension was greater than the last, so we are enabled by means of the rays of light to span, as it were, these two dimensions, and to judge or estimate their relative proportion by means of the greater or lesser separation of the rays, as indicated by the size of the visual angle.

This proposition may be thus expressed, namely:

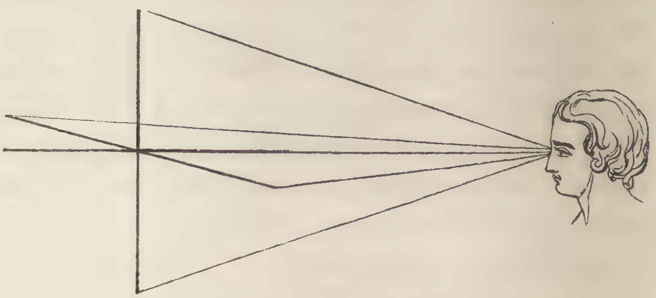
The length, or apparent length, of a line is estimated by the actual size of the visual angle which it forms at the eye.

Of Foreshortening.

But independently of the *length* of a line, its *direction* with reference to the position of the eye contributes to modify the size of the visual angle, and consequently the apparent length of the line.

For, if I hold this straight line (see diagram, next page) square opposite the eye, (that is, with the eye equally distant from its extremities,) the visual angle which it forms at the eye is greater than when I place the wire sideways or obliquely towards the eye (*i. e.*, with the eye unequally distant from the extremities of the line). And the more the wire is inclined the smaller does the visual angle become, until at last the line may be so placed, with the eye in the direction of the line produced

or continued, that the two rays of light proceeding from the extremities of the line to the eye would meet, and the visual angle become nothing. But



as we have established the rule, that the length of a line is estimated by the size of the visual angle, (and the rays of light afford the only means of judging of length without actual measurement,) the line would in this last position, when the two rays are brought to coincide, necessarily *appear* as a point, although its *actual*, its *real*, length would remain unaltered.

We may hence establish the following rule, namely:

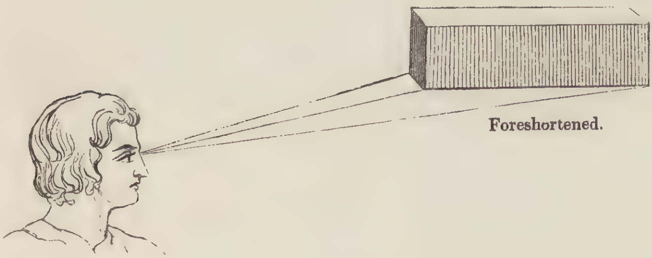
When a line is placed square opposite the eye, i. e., with its extremities equally distant from the eye, its apparent length is greater than when it is placed obliquely towards the eye, i. e., with its extremities unequally distant from the eye; and the more obliquely the line is placed with reference to the eye the shorter it appears, until at last it may be so placed, with the eye in the direction of its length, that it shall appear only as a point.

The diminution in the apparent length of a line, caused by its obliquity with reference to the eye, is expressed by saying that the line is foreshortened.

This effect has been illustrated with the wire, the threads, and the model of the eye; the teacher further exemplifies the proposition by moving a straight wire slowly round, presenting it in succession to the several members of the class in such positions that it will appear considerably foreshortened.

We have now the means of accounting for the change in the appearance of the model or book, to which attention was previously directed (page 43),

namely: that by inclining the model back from the class, its height, which before had appeared greater



Foreshortened.

than its width, now appears less than its width. The line marking the height of the model, being in the second position placed obliquely towards the class, appears foreshortened.

This effect of foreshortening is also shown in the annexed diagrams, of which the first represents a row of pillars, viewed in front, and there-

Front View.

Foreshortened or Oblique View.

fore of the full width, and the second the same row of pillars viewed obliquely, and therefore foreshortened.

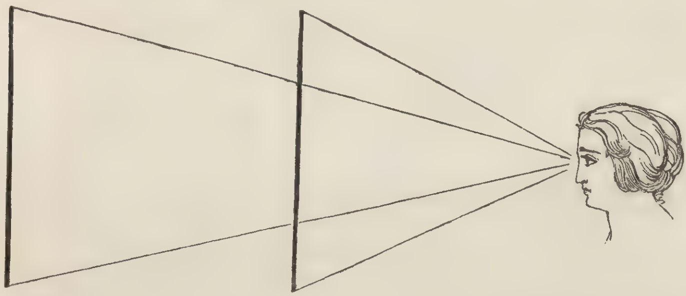
Chapter IV.

PRINCIPLES OF PERSPECTIVE.

Of the Effect of Distance on the Size of the Visual Angle.

Independently of the *length* and the *direction* of a line, its *distance* from the eye contributes towards determining the size of the visual angle, and consequently modifies the apparent length of the line.

This wire being held upright, and at a certain distance from the supposed eye, forms a visual angle of a certain size; if I remove the line to a greater distance from the eye, keeping it in the same vertical position, it forms a visual angle of a smaller size. In the second position it would therefore appear smaller than in the first.



Or, keeping the wire fixed in a vertical position, if I cause the threads to meet at a point close to the line, which point of meeting is supposed to represent the position of the eye, the visual angle is evidently larger than if I cause the threads to meet at a point removed to a greater distance. In the first supposed position of the eye the line appears therefore longer than in the second position, for we

have established the rule, that it is by means of the size of the visual angle that we judge of the apparent length of a line.

That this is exactly the effect produced by distance is made manifest when we look at a row of trees, or columns, or a long line of street, road, or railway, of which every part throughout the entire length is equally broad; the breadth (as shown in the annexed diagram) nevertheless appears to diminish as the distance is increased.

For the same reason, if we look at a long row of columns, houses, or of lamps, or of any objects

which are in reality all equally high, we find that the heights likewise appear to diminish as the distances are increased.

In the same manner, if we look up a circula-shaft, or down a circular well, every part of which is throughout the whole height or depth, of the same width and size, we find that the opening of the shaft at top, or the circular appearance of the well at bottom, appears considerably less than their circular openings near the eye, although we know that no difference really exists. This effect is universal; innumerable instances might, therefore, be cited as examples; but the above, with the illustration given by means of the model, will suffice to establish the following rule, namely:

As the distance of a line or object from the eye is increased, so is its apparent length or size diminished.

It follows directly from this rule, that the distance of a line or object may be conceived to be so great that its apparent size would diminish or vanish into a point. Striking examples of this effect are presented by very long and straight lines of railways or canals, the sides of which actually appear at the extreme distance to meet in a point; at that extreme distance, therefore, the width appears as nothing. The reason of this effect is, that the visual angle formed by the width of the railway or canal at that very great distance is so small as to be inappreciable, or incapable of being estimated by the eye*.

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* No precise statement can be made as to the least angle under which any object is visible, for the angle is found by experiment to vary materially according to the shape of the

Experience teaches us to correct Optical Illusions.

Although the effect we describe is both true and universal, experience enables us to form a judgment of the approximate real magnitudes of unknown distant objects, by making an allowance for the diminution of the visual angles due to the respective distances of the objects, and thus correcting the optical illusion above described. The idea of the distance of an unknown object is itself formed from the concurring effects of the comparative degree of clearness with which it is seen, the number of intervening objects, the angle of the apparent inclination of the intervening plane on which the object stands, &c.; and when all or any

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object, and the intensity of the light it sends forth. For example, it is found that a line can be seen at a greater distance than a circular spot of the same diameter as the line; and a star which appears only as a lucid point through a telescope, subtending not so much as an angle of 1 second, is visible to the eye, though a white or black spot of 25 seconds is not perceptible. According to the *Aide Mémoire,* a work published for the use of topographical engineers and others, the windows of a large house can generally be counted at the distance of three miles; men and horses can just be perceived as points at about 2,200 yards; a horse is clearly distinguishable at 1300 yards; the movements of a man at 850 yards; a man's head clearly visible at 400 yards; and partially so between that distance and 700 yards. These distances must evidently vary according to individual powers of vision, clearness of the atmosphere, and other influencing causes; but the above are given as the results of general experience.

It is by increasing the size of the visual angle by causing a more rapid convergence of the rays of light, that telescopes enable an observer to distinguish objects at a greater distance than by the naked eye.

of these means are wanting, or when they are offered in circumstances differing from those habitually presented to our consideration, we then fail in duly estimating distances, and, as a consequence, judge erroneously of magnitude. For example, if we look over an expanse of water on which no intervening objects can serve to assist the judgment, we are likely to form false ideas of distance: as also, if we place our eye on a level with a line of road, and thus alter its apparent inclination to an angle to which we are not accustomed, we form a less perfect idea of the distance than when our eye is placed at the customary elevation above the road. The effect of fog in misleading the judgment in the estimation of distance is likewise well known. The draughtsman, or artist, therefore, in his representation of objects, gives them the proper relative apparent magnitude as indicated by the size of the visual angle, and aims at introducing into the picture or drawing the same effects which guide or influence our judgment in the natural scenery.

Actual and Apparent Directions of Lines not always the same.

Pursuing our inquiries with reference to the course of the rays of light as they proceed to the eye, we next find that the *actual* and the *apparent* directions of lines are not always the same.

If an observer stand in the middle of a long, straight, and level street, and look down the

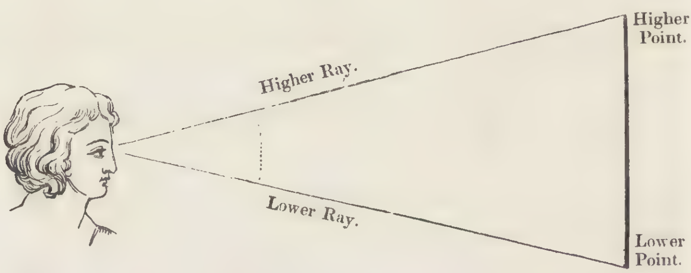
middle of the street, the upper lines of the houses will appear, as their distance from the eye increases, to tend *downwards* towards a point on the level of the eye. The lines of the houses on each side will appear, as their distance from the eye increases, to tend *inwards* towards the same point. Lastly, the street itself, or roadway, will appear, as the distance from the eye increases, to tend *upwards* towards the same spot.

In the same manner, if an observer stand at one extreme end of a vast edifice (a cathedral for example), and look down the middle of its spacious nave, he will notice that the higher lines of the edifice seem to tend *downwards* as their distance from the eye increases; that the side aisles seem to tend *inwards* as their distance from the eye increases; and, lastly, that the floor of the edifice seems to tend *upwards* as the distance from the eye is increased.

These appearances are so striking on a large scale, that all who have their attention directed to the fact cannot fail to observe them: the same causes, however, produce similar results with shorter lines, and we shall investigate the causes by considering as before a simple straight line.

If a straight line is fixed in a vertical position, the lower extremity of the line appears below its higher extremity, and *vice versâ*. This is self-evident; there cannot be with any one a shadow of a doubt on this head: but as other positions may be given to the line, in which the relative apparent elevation of its extremities is not so self-evident, or so manifest at the first glance, let us examine why the lower extremity of this upright or vertical line appears below its higher extremity.

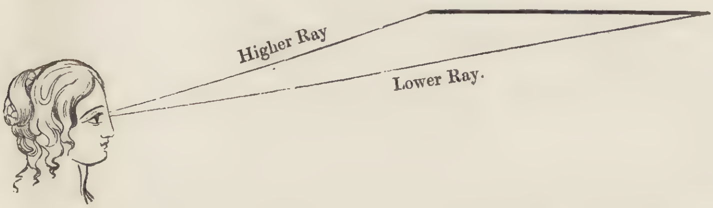
By referring to our illustration of the course of the rays of light as represented by threads, we see



at once that the ray of light which conveys to the eye the image of the lower extremity is lower in its course towards the eye than the ray of light which conveys the image of the higher extremity; and as it is only by means of the rays of light that

the eye receives the image of the line, the lower extremity of the line appears lower than its higher extremity.

If the position of the wire be now changed, placing it at a higher elevation than the eye, with its extremities on the same level, but unequally distant from the eye, we find that the ray of light which conveys to the eye the image of the distant extremity is *lower* in its course towards the eye,

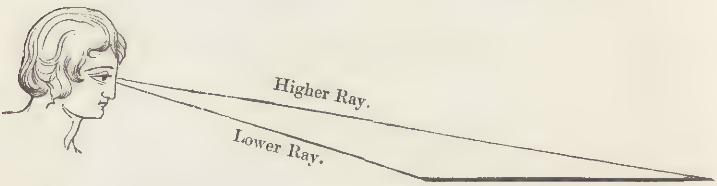


than the ray of light which conveys the image of the near extremity; the distant extremity appears therefore lower than the near extremity: or, as it may be expressed in other words, the line as it recedes from the eye appears to tend downwards from the nearest point.

Comparing this effect with that of the apparent downwards tendency, as the distance is increased, of the upper lines of the houses, in the example we before selected for illustration (see page 66), we perceive that the same reason accounts for the appearance observed, namely, that the rays of light proceeding from the distant points towards the eye are lower in their course than the rays of light passing from the nearer points.

Next placing the wire at a lower elevation than

the eye, and with its extremities on the same level and unequally distant from the eye, we shall find that the ray of light which conveys to the eye the image of the distant extremity is *higher* in its course towards the eye, than the ray of light which conveys the image of its near extremity; the distant extremity appears, therefore, higher than the near extremity, or, as it may be expressed in other words, the line as it recedes from the eye appears to tend

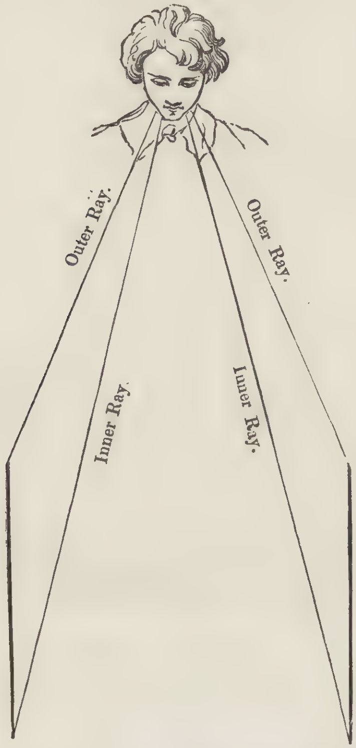


upwards from the nearest point. Comparing this effect with that of the apparent upwards tendency, as the distance is increased, of the street on which the spectator is supposed to stand in the example we before selected for illustration (see page 66), we perceive that the same reason accounts for the appearance observed, namely, that the rays of light proceeding from the distant points towards the eye are higher in their course than the rays of light passing from the nearer points.

To illustrate the effect of the sides of the street appearing, as the distance is increased, to tend *inwards* when the spectator stands in the middle of the street, the teacher will place horizontally and parallel to each other two wires, stretching from their extremities, threads to a fixed point on the

same level with them, and placed midway between their directions produced or continued.

In this illustration, the rays of light proceeding from the remote extremities are inside of the rays proceeding from the near extremities; the lines as their distance increases would therefore seem to tend inwards to an eye placed in the position of the



fixed point. This is an effect precisely similar to that observed by a spectator standing in the middle of the street, and to whom the sides of the street appear to tend inwards as the distance is increased. (See Illustration, page 66.)

Lines tending to the Right.

If the observer change his position, and, standing in the middle of the footway on the right of the street, look down the footway, he will find that, for example, the row of lamps on each side of the street will, in this new position, both seem to tend towards the right as the distance increases; and were he then to change to a similar position on

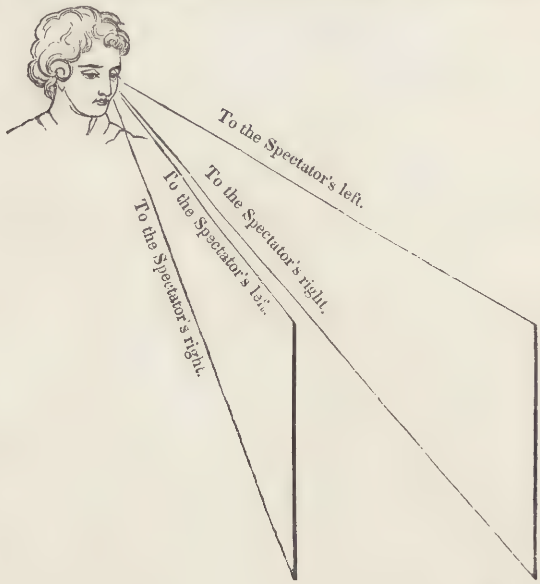
Lines tending to the Left.

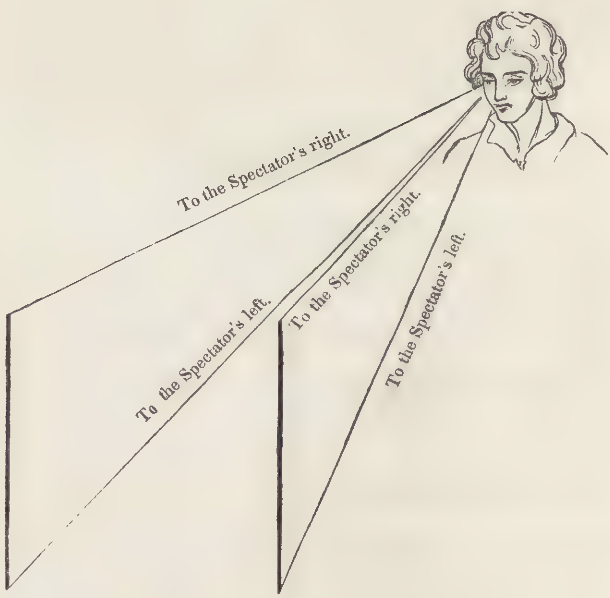
the left of the street, they would then seem to him to tend towards the left, as the distance increased.

To imitate the effect produced by the observer thus changing his position, let the teacher remove the point, towards which the threads converge, to the right of the lines produced.

In such a position, the rays of light conveying the image of the remote parts of the lines, are

to the right of the rays conveying the image of the near parts; the lines, therefore, as they recede from the eye, appear to tend towards the right.





A similar appearance will take place in the opposite direction, if the point of convergence be removed to the left of the lines produced.

The teacher will now replace the wire above the level of the eye, so that the point of convergence of the threads shall be *equally distant* from the extremities of the line.

In that case the line will appear horizontal, because the rays of light passing from its extremities towards the point representing the position of the eye will be on the same relative level throughout their course. And so long as the extremities of the line are equally distant from the eye, it will always appear horizontal, no matter whether it be above, below, or on the level of the eye.

Horizontal.

But when there is an unequal distance between the extremities of the line and the eye, then (except when the eye and the line are on the same level,) a change in the direction of the line seems to take place, and the greater the difference in the distance the more marked is the change. The teacher will illustrate this at the same time that he gives the enunciation, by placing the wire by degrees more and more obliquely towards the point of convergence of the threads.

When the eye is on the same level as the line, the true and apparent directions are the same; this

will be illustrated by the master with the threads and wire, changing the position of the point of convergence of the threads, but still keeping it on the same level as the wire.

From the above considerations we deduce the following rules:

If the eye be to the right *of a line, or a line continued, the line, as it recedes from the eye, appears to tend towards the* right *from the point which is nearest the eye.*

If the eye be to the left *of a line, or a line continued, the line, as it recedes from the eye, appears to tend towards the* left *from the point which is nearest the eye.*

If the eye be above *a line, or a line continued, the line, as it recedes from the eye, appears to tend* above *or* upwards *from the point which is nearest the eye.*

If the eye be below *a line, or a line continued, the line, as it recedes from the eye, appears to tend* below *or* downwards *from the point which is nearest the eye.*

When the eye is equally distant from the extremities of a line, its true and apparent directions are the same.

When the eye is on the same level as a horizontal line, its true and apparent directions are the same, whether the extremities of the line be equally or unequally distant from the eye.

The changes which take place in the apparent directions of lines may be resumed in the following brief statement.

If a cube or a similar body be above the eye, its under side is seen; if below the eye, its upper side is seen; if to the left of the eye, its right side is seen; if to the right of the eye, its left side is seen; and when exactly square opposite to the eye, the front side alone is seen.

Observations suggested by the preceding investigations.

When representing an object, whether simple or complex, the pupil will mark, in the first instance, the apparent positions of the salient or striking points of the object which are nearest the eye; and, having marked those points, he will determine the apparent directions of the lines receding from those points, by means of the preceding rules.

The foregoing explanations of the more striking effects of perspective should be understood before the pupils (in a *simultaneous* course of instruction) can commence to draw from the first or simplest of the series of wires, namely, that which represents a straight line, for that line appears different from every different point of view. In fact, one great object of these preliminary demonstrations consists in convincing the pupils, that the actual and apparent forms of objects are not identical, and that the apparent forms vary with every change of position of the spectator with respect to the object.

This important and fundamental principle having been made manifest to the pupil, it is not improbable that a question to this effect may be pre-

sented to his mind: How can we acquire a knowledge of the forms of objects by the sense of sight, if the appearances of objects, or the images which they present to the eye, be different from their real forms? This, like the question which relates to the effect of our seeing only one image with two eyes, involves some metaphysical considerations if treated in its full bearing. For our present object it is sufficient to observe, that it is only by the constant aid of the sense of touch that the child learns to appreciate the *real* forms of objects by means of their *apparent* forms. To the infant, not only does a circle, seen obliquely, present an appearance resembling that of an ellipse, but the circle, when thus viewed, can convey to his mind the idea of an ellipse only, until he has by the sense of touch, as also by seeing the same figure from many different points of view, learned to deduce the idea of its true form from the unlimited variety of images which that single form may present.

So constantly is this operation performed, and so habitual is the resolution of perspective appearances into their origin, that at last the deduced idea acquires a stronger hold on the mind than the original idea, the result of the actual sensation, and the child thinks that a circle or a square, whether viewed obliquely or in front, appears to him similar, and it requires some instruction to convince him of the inaccuracy of such a conclusion.

The following exercises aim, therefore, partly, not at making the child unlearn that which he has

learned from the first moment he brought the sense of touch to aid that of vision; but at teaching him to superadd to that knowledge a perception of the first sensations he must have experienced from the earlier exercise of his sense of vision, before it had been assisted by the sense of touch. The child has been daily and hourly learning to deduce the *real* from the view of the *apparent* forms; he is now to be taught to deduce the apparent from his knowledge of the real forms.

Chapter V.

APPLICATION OF THE FOREGOING PRINCIPLES TO PRACTICE.

Preliminary Remarks.

When a definition is referred to by the teacher, the model representing the line or figure described is to be presented to the class at the same time that the definition is given.

At different intervals throughout the following exercises the definitions are introduced only as they become necessary for the proper solution of the problems that immediately follow. This separation of what may be considered parts of the same subject is adopted for the purpose of adhering to this useful maxim in elementary teaching, namely, that practice should always, if possible, accompany theory; the use of the definitions is thus made manifest to the child's apprehension, through their immediate application.

It is necessary to observe that the numerous diagrams introduced in this chapter are designed solely for the use of the teacher, who may refer to them as approximate guides for the direction of lines or shapes of figures. We say approximate guides, because each pupil, seeing the model differently from the other members of the class, the three different diagrams given in illustration of the appearance of such model can only be true from three fixed points of view. The words "left," "middle," "right," placed beneath each series of the diagrams, indicate that the general appearance shown corresponds to that presented by

the model as viewed either from the left, middle, or right of the class-room.

The teacher has to place the wires in certain determined positions, such as vertical, or horizontal, or otherwise. In order to do so with precision, he will refer the direction of the wires to certain known and fixed directions of lines in the class-room. For example, to place a wire in a vertical position it will be sufficient to fix it so, that, holding it in succession between the eye and two or more vertical lines in the room, it will appear to coincide with them in all its parts. Also, to place a wire in a horizontal position, the teacher will fix it in a vertical plane parallel to any side of the room, and placing his eye at a proper elevation with respect to the wire, see if it appear to coincide in every part with the line marking the intersection of the side of the room with the ceiling.

The teacher will make use of the sight-rule (see page 151) to assist him in correcting the drawings of the pupils.

The paragraphs which contain directions for the pupils may be communicated either literally or in substance.

The terms "right" and "left," when used in describing the direction of lines, or determining the position of models, refer to the right and left of the pupils when in their places.

The class is now prepared to commence drawing. Each pupil has before him his drawing-slate and chalk-holder, with the white chalk properly pointed.

As a general rule, the models presented to the class are to be drawn as nearly as possible of the full size, whenever their dimensions do not exceed those of the drawing-slate. Lines are drawn from left to right, and from top to bottom.

Definitions.

The *straight* line needs no definition: it is only required to grant that a straight line can be prolonged or *produced* to any length from either extremity.

Horizontal or *level* lines are straight lines that are parallel to the surface of still water. Lines on the floor of the room, for example, are said to be level or horizontal. On the drawing-slates, or on rectangular sheets of paper, &c., which are moveable in any direction, lines cannot of themselves be horizontal; an understanding must, therefore, be had as regards the direction of lines which are to be assumed as horizontal on the drawing-slate, paper, &c. On the drawing-slate, lines are said to be horizontal when they are parallel to the upper or lower edges of the slate.

Horizontal Line.

[The pupils to draw one or more horizontal lines.]

Vertical or *upright* lines are straight lines parallel to the direction of a plumb-line. The lines formed by the meeting of the sides of the room, for example, are vertical. On the drawing-slates lines are said to be vertical when they are parallel to the sides of the slate.

[The pupils to draw one or more vertical lines.]

Vertical Line.

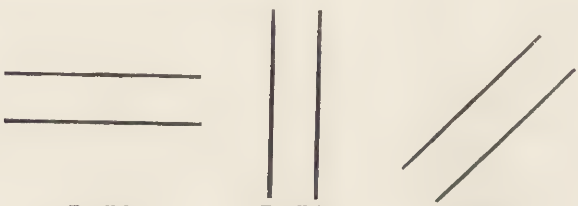
Oblique or *slanting* lines are straight lines in any direction, except horizontal or vertical; for example, the sides

of the roof marking the gable end of a house, are said to be oblique or slanting lines.

Oblique or Slanting Lines.

[The pupils to draw one or more oblique lines.]

Parallel lines are lines that are, in every part throughout their length, equally distant from each other; for example, the upper and lower edges of the drawing-slates are said to be parallel lines.



Parallel Horizontal Lines. Parallel Vertical Lines. Parallel Oblique Lines.

Curved lines may also be said to be parallel.

[The pupils to draw parallel horizontal lines.]

[The pupils to draw parallel vertical lines.

[The pupils to draw parallel oblique lines.]

On the drawings, or perspective representations of lines not vertical, the teacher will, throughout the first series of outline exercises extending to the square inclusively, cause the pupils to write the letter *n* to indicate the point which represents that extremity of a line *nearest* to the eye, and *d* to indicate the point which represents that extremity most *distant* from the eye; thus, as is indicated in the annexed representation of an upright square frame viewed from the right and from beneath the level of the square. The mere writing of these letters will often indicate an error to the reflecting pupil, who will be enabled to correct it without the teacher's assistance.

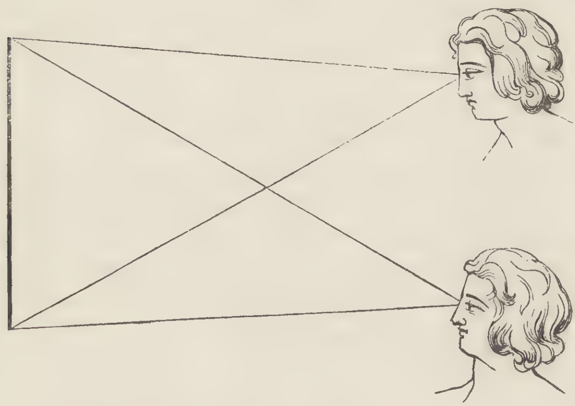
WIRE MODELS.

Model.

A Straight Line.

First Position. *The wire vertical or upright.*

A vertical line appears vertical from every point of view, the ray of light which conveys to the eye the image of its lower extremity being vertically below the ray of light which conveys



to the eye the image of its upper extremity. This will be illustrated by the threads, wire, and eye-model, showing that, whichever way the vertical line may be placed with reference to the supposed eye, the threads representing the rays of light are vertically below one another.

The line is to be drawn from top to bottom parallel to, or equally distant throughout its length from the sides of the slate. A truly vertical line of any considerable length is difficult to be drawn, and the teacher will find that a considerable time will be required, before perfect skill is therein attained—he will remain satisfied at first with a tolerable approximation.

Second Position. *Wire horizontal, parallel to the head or upper side of the room.*

As the line cannot be placed on the level of the eyes of all the members of the class, in which position it would appear horizontal to all, the teacher will place it at an elevation of from two to three feet above the level of the eyes of the pupils, in order that the change between its true and apparent directions may be more manifest.

The line is to be drawn from left to right, subject to the modifications explained as follows.

1. As to its apparent length, or degree of foreshortening. Those pupils who are in the middle of the room being square opposite to the line, see the true and apparent length the same; but it appears to diminish gradually, and in a slight degree to the pupils, as they are placed more and more nearly towards the sides of the room, from which positions, as they view the line obliquely, so they view it foreshortened.

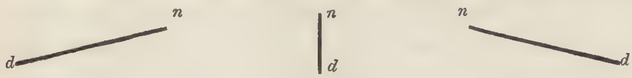
2. As to its apparent direction. Those pupils who are in the middle of the room, being square opposite to the line, see it level or horizontal, the rays of light proceeding from the extremities of the line to the eye being of the same relative elevation throughout their course. To those who are placed towards the sides of the room, and therefore obliquely or sideways towards the line, as well as below the line, it appears to tend downwards from the nearest point.

The representation of the wire will be therefore as in the annexed figure.

Third Position. *Wire horizontal, at right angles to the last position.*

To all the class the wire appears foreshortened; it also appears to tend downwards from the point nearest to the eye. Further, to those who, being in the middle of the room, are in the direction of the line itself, it can tend neither to the right

nor to the left, but simply downwards. To those who are placed to the right, it seems to tend towards the right from the



Left. Middle. Right.

point nearest to the eye. To those who are placed to the left, it seems to tend towards the left from the point nearest to the eye. The farther each pupil is removed from the middle of the room, the more nearly level does the line appear, as he is more nearly square opposite to it.

Fourth Position. *Wire horizontal, inclined half a right angle to the last position.*

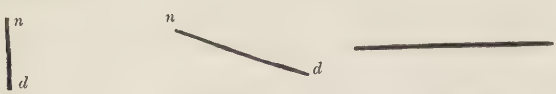
To all those pupils to whom the line appears foreshortened in consequence of its obliquity, it appears to tend downwards, because the circumstance of its obliquity shows that one of its extremities must be more distant than the other from the eye

Left. Middle. Right.

which is placed below it. But to those who may be placed exactly in front of the line, it will appear horizontal, both its extremities being equally distant from the eye.

Fifth Position. *Wire horizontal, and at right angles to the last position.*

The appearances will be similar to the last, but in a reverse order, thus:—



Left. Middle. Right.

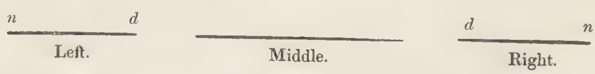
The teacher, retaining the wire in its horizontal position, will lower it so as to place it as nearly as possible on the level of the eyes of the majority of the class.

All those who may be placed on the same level with the

wire will see it level. With respect to those who may be placed either above or below the wire, inasmuch as the difference in elevation will be a very small quantity, so will the apparent deviation from the horizontal direction be inconsiderable, the line according to the rules appearing to tend *upwards* from the nearest point for those who continue to be placed *above* it, and appearing to tend *downwards* from the nearest point for those who may be placed below it. Those who see the line from a place equally distant from both its extremities, of course see it level; to them the rule in question is inapplicable, as they cannot refer to the *nearest point.*

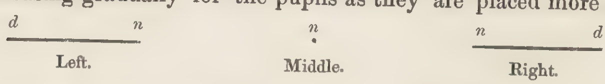
The chief object of the exercises presented by this position is to apply the rules connected with the foreshortening of lines, and for this purpose the wire will be placed in succession in the following positions similar, except in height, to those that precede, viz.:—

1. *Wire horizontal, parallel to the head or upper side of the room.* For those who may be on the level of the line, its appearance will be as follows:—



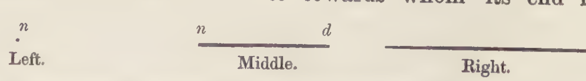
foreshortened in some degree at the sides of the room.

2. *Wire horizontal, at right angles to the last position.* Its appearance is least for those who are in the middle of the room, increasing gradually for the pupils as they are placed more and



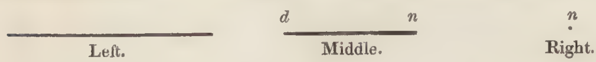
more nearly towards the sides; some, in the centre of the room, may see the line as a point.

3. *Wire horizontal, inclined half a right angle to the last position.* The apparent length of the wire, and therefore its representation, is least for those towards whom its end is



directed, increasing gradually in length for each pupil as he is placed at a greater distance from those first named.

4. *Wire horizontal, at right angles to the last position.* The appearances are similar to the last, in a reverse order.



If the arrangement of the class-room be such as to admit of the wire being placed about two feet below the level of the eyes of the pupils, without its being hid from view by those in the front desks, the teacher will cause the wire to be drawn in this new position, presenting it to the class in four points of view similar to the last. The change in the appearance of the line, compared with its appearance as drawn previously, will consist in this,—that it will now seem to tend upwards from the point nearest the eye, instead of inclining downwards as in the preceding examples. It will be found, however, that the general arrangement of the desks, in many school-rooms, will not enable the teacher to place the model much below the eyes of the pupils, and yet so that those sitting in front shall not interrupt the view of the model for those occupying the back desks.

Hints on the Inspection of the Drawings.

The teacher is not to expect that in the preceding and some of the following exercises the apparent lengths and inclinations of the lines will have been represented by all the pupils with accuracy; he will remain satisfied with an approximation sufficiently close to be an evidence of a proper understanding of the principles of perspective which have been explained. The accuracy of eye and steadiness of hand necessary to represent the model with perfect truth could not of course be so quickly acquired; but the teacher will observe a gradual improvement in these, the result of practice, at each succeeding exercise. We think it necessary, however, to caution against allowing too great a departure from straightness in the line, for the pupil knowing that

the drawing is to be effaced as soon as made, may fall into a habit of drawing these with less skill than he is capable of showing, unless he sees neatness of hand valued by the teacher as well as the more important power of a clear understanding of principles.

Should the teacher find that in the preceding, or in future exercises, the principle has been misunderstood by some, (that is, that the judgment, and not the eye and hand merely, is at fault,) he will repeat with the threads and the eye-model the illustrations from which the principle itself has been deduced, and he need not fear that such illustrations may be repeated so often as to become of no interest even to those who had not committed the error. Ocular demonstrations are of themselves interesting, but the attention will be more effectually secured by conducting them according to the elliptic method, in which the members of the class themselves perform half of the reasoning, and point out the conclusions that naturally follow from the demonstration.

Chapter VI.

APPLICATION OF PRINCIPLES TO PRACTICE.

Definitions.

[The teacher will not fail to illustrate these definitions, by presenting to the class the wire model corresponding to each angle defined.]

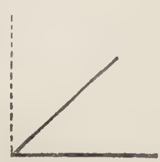
Angles or *corners*, such as those formed by the meeting of the edges of the drawing-slates, or by the intersections of the lines of a carpenter's square, or by the meeting of the sides of the room, are called square or right angles. They may also be defined thus: When a straight line standing on another straight line makes the angles on each side equal to one another, each of the angles is called a right angle.

A straight line forming a right angle with another straight line is said to be *square* or *perpendicular* to it.

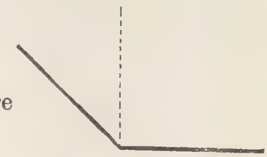
[The pupils to draw one or more right angles.]

A *sharp* or *acute* angle is an angle smaller than a square or right angle.

[The pupils to draw one or more acute angles.]



A *blunt* or *obtuse* angle is an angle larger than a square or right angle.



[The pupils to draw one or more obtuse angles.]

A *plane* or a *flat* surface is one on which a straight line can be applied in any direction so as to touch in every part; for example, the slate, the ceiling, the side wall of the room, and similar surfaces. The surface alone, not the thickness, is meant.

Model.

Two Straight Lines forming a Right Angle.

First Position. *One line vertical, the horizontal line above the level of the eye, parallel to the sides of the room, and with the angle next to the class.*

The vertical or upright line appears, and is to be represented vertical, but to all the class the horizontal line appears foreshortened, and seems to tend or incline downwards from the nearest point; and as the nearest point is at the angle formed by the junction of the two lines, that angle will to all the class appear more or less obtuse, the obtuseness or size of the angle diminishing as each pupil is further removed towards the sides

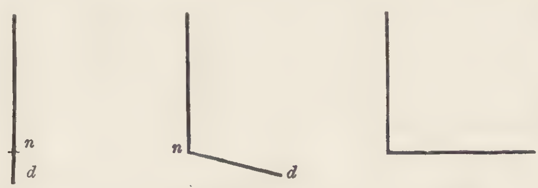
Left. Middle. Right.

of the room. Those who are placed to the right of the horizontal line see it apparently tending towards the right from the nearest point; consequently the angle to them is on the left of the drawing: those who are placed to the left of the horizontal line see it apparently tending towards the left; to them consequently the angle is on the right of the drawing. Those in the middle of the room, who may be placed in the same vertical plane with the horizontal line,—in other words, those who are

neither to the right nor left of it,—will see it tending or inclining simply downwards, and the two lines of the model will appear in the same straight line. The angle in this case may be supposed to have become so blunt or obtuse, as to become equal to two right angles; and from this limit, in the middle of the room, the angle gradually diminishes towards the sides until it would appear as a right angle, if any were placed so far round as to be square opposite to the horizontal line, and not to see it foreshortened.

Second Position. *Retaining the model at the same elevation, direct the point of the horizontal line towards the right-hand corner at the head of the room.*

If any of the pupils, in the left of the room, be in the direction of the horizontal line, the model will present the appearance of a straight line, the horizontal line seeming to tend directly downwards from the point nearest to the eye. If, on the other hand, any of the pupils in the right of the room be



Left. Middle. Right.

exactly in front of, or at right angles to the middle of the horizontal line, its true and apparent direction will be the same, because both its extremities will be equally distant from the eye: the angle to these appears, therefore, as a right angle. For those pupils placed between these two limits, the apparent direction of the horizontal line, by tending more or less downwards from the point nearest to the eye, will seem to make with the vertical line an angle more or less obtuse according as they are placed more nearly to the left or right of the room.

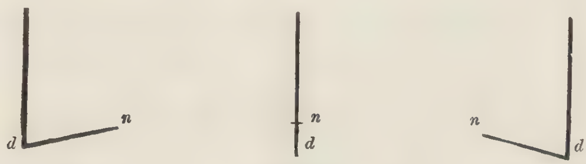
Third Position. *Place the horizontal line at right angles to the last position, retaining the angle on that side nearest to the class.*

The appearances will be in this position similar to the last, in a reverse order.

Left. Middle. Right.

Fourth Position. *Similar to the first, except that the angle in the model is to be placed next the head of the room, the point of the horizontal line being directed towards the class.*

The vertical line, as before, is to be drawn vertical, and as to all the class the horizontal line seems to incline downwards from the nearest point, the angle in the model will to all appear more or less acute, the acuteness of the angle diminishing as each pupil is further removed from the middle of the room.



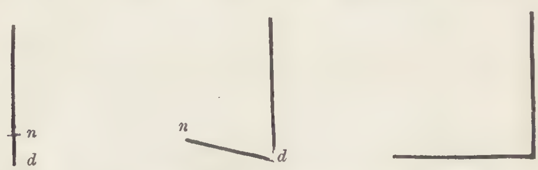
Left. Middle. Right.

Those who are placed to the right of the horizontal line prolonged, see it apparently tending towards the right from the nearest point; consequently the angle to them is on the right of the drawing. The appearance is similar, but in a reverse order, for those who are on the left of the horizontal line produced. Those who may be placed in the same vertical plane with the horizontal line,—in other words, those who are neither to the right nor to the left of it,—will see it inclining simply downwards from the nearest point, and the two lines of the model will appear in the same straight line. The angle in this case may be supposed to have become so sharp or acute as to vanish or present a mere point, the two lines which formed the angle coinciding and appearing as one. From this limit, in the middle of the room, the angle gradually increases towards the sides,

until it would appear as a right angle, if any were placed so far round as to be square opposite to the horizontal line, and not to see it foreshortened.

Fifth Position. *Place the model with the horizontal line at half a right angle to its last position, the point still directed towards the class.*

If any of the pupils be in the direction of the horizontal line, *i. e.* in the same vertical plane with it, the model will present the appearance of a straight line, the horizontal line seeming to tend directly downwards from the nearest point. If, on the other hand, any of the pupils be exactly in front of, or square opposite to the horizontal line, its true and apparent direction will be the same, because both its extremities will be equally distant from the eye: the angle to these appears, therefore, as a right angle.



Left. Middle. Right.

For those pupils placed between these two limits, the apparent direction of the horizontal line, by tending more or less downwards from the nearest point, will seem to make with the vertical line an angle more or less acute according as they are placed nearer to the first or last described position.

Sixth Position. *Horizontal line at right angles to the last position, retaining the point towards the class.*

The appearances will be similar to the last in a reverse order.

Left. Middle. Right.

As was explained in the case of the simple line, the model will next be placed with the horizontal line as nearly as may be

on the level of the eye of the majority of the class, adopting for it in succession positions similar to those previously described. The vertical line in these, as in all other exercises, will be drawn vertical; the direction and amount of foreshortening of the horizontal line will, therefore, be the only properties of the model admitting of modification; it is unnecessary, however, to explain categorically each series of appearances, the representation of the horizontal line, under such circumstances, having been explained in pages 90 and 91.

Also in this case, as in that indicated for the straight line, if the arrangement of the class-room be such as to admit of the model being clearly seen by all, when placed about two feet below the level of the eyes of the pupils, the teacher will cause the model to be drawn from such a point of view, in positions corresponding to those described when the model was above the eye. The change in such a case in the appearances presented in succession by the model will consist in this, that the horizontal line will now appear to rise or tend *upwards* in the corresponding positions to those in which it had appeared to tend *downwards;* and where the angle appeared obtuse it will now appear acute, and where it appeared acute it will now appear obtuse.

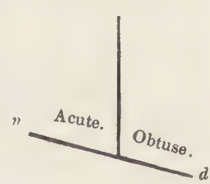
It is sufficient to observe that, in all future cases, it will be desirable to place the model below the eye occasionally, for the purpose of varying the perspective as much as possible, in those rooms where the arrangements of the desk will permit the model to be distinctly seen by all when so situated.

Model.

A Straight Line raised at Right Angles from the Middle of another Straight Line.

The teacher will turn back to page 95, and present this model in successive positions similar to those used for the preceding model of the right angle. The apparent changes in its form will be explained by reference to the same principles, and in nearly the same words.

Before giving directions for the drawing to be commenced of each new position, it will be desirable to direct the attention of the class by questions, or in preference by the elliptic method of instruction, to the character of the angles as they appear from certain determined points of view. For example, supposing the model placed above the eye with the shorter line vertical, and the horizontal line parallel to the sides of the room. The near angle appears (acute) to all the class; the distant angle appears (obtuse) to all the class. The near angle appears most acute (in the middle of the room), and so on, varying either the mode of leading the answer, or the form of the question.



Model.

Two Straight Lines bisecting each other at Right Angles.

This model being composed of those which precede, the teacher will again turn back to page 95, and present it to the class in positions similar to those used for the simpler type. The apparent changes in the form will evidently be explained by reference to the same principles, and in nearly the same terms.

This model will also afford useful opportunities of fixing the attention of the class by questions with reference to the apparent character of any angle which may be pointed out by the teacher, or as regards the foreshortening or direction of any of the lines. In all these examinations the answers will be made simultaneously by all the class, and the teacher will note with care any error that may be made in the answer, although the error might be committed by only one or two pupils. Without indicating individually the pupil who may have answered wrong, he will repeat the answer as given, reason upon it (if necessary with the aid of the threads and eye-model), and by demonstration lead the class generally, as well as the pupil who was in error, to detect and to correct that error; and thus the erroneous answer, instead of impeding the progress of the class, is made subservient to the general advancement, as opportunities cannot be too frequently taken advantage of for the purpose of explaining and dwelling upon the fundamental principles.

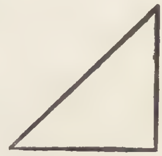
Definitions.

A *triangle* is a figure containing three angles.

A *right-lined* triangle is a figure bounded by three right or straight lines.

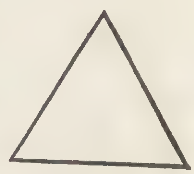
A *right-angled* triangle is that which has a square or right angle.

[The pupils to draw one or more right-angled triangles.]



An *acute-angled* triangle is that which has three sharp or acute angles.

[The pupils to draw one or more acute-angled triangles.]



An *obtuse-angled* triangle is that which has a blunt or obtuse angle.

[The pupils to draw one or more obtuse-angled triangles.]

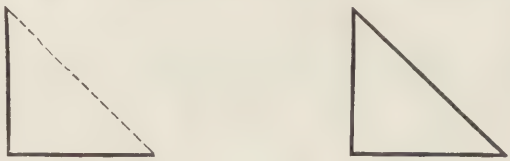
The lowest side in a triangle is said to be its *base.*

A plane, or a flat surface, may be supposed capable of being extended without limit in any direction.

Model.

A Right-Angled Triangle.

Comparing this model with that which consists of two straight lines forming a right angle, the class will perceive that the difference consists in the addition of a straight line



joining the extremities of the wires in the simpler model. It is evident, therefore, that the same principles which guided the class in its delineation are all that will be required in drawing the more complex, as by beginning with the sides that form the right angle, when these are properly drawn, the figure will be completed by joining their extremities by a straight line.

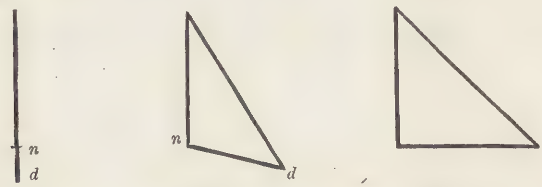
First Position. *The model above the level of the eye, one leg of the triangle vertical, the other parallel to the sides of the room, the angle being next to the class.*

Those pupils in the middle of the room who may be in the same vertical plane as the figure, or in the direction of the horizontal line produced, will see the model as a straight line, the base appearing to tend neither to the right nor left, but simply downwards from the nearest point. The further each pupil is

Left. Middle. Right.

removed from the middle of the room, the wider does the triangle appear, the less obtuse does the angle next the class become, and the less does the base of the triangle depart from the horizontal direction. The triangle appears obtuse-angled.

Second Position. *The model to be placed in a vertical plane inclined half a right angle to the last, the right angle still remaining next to the class.*



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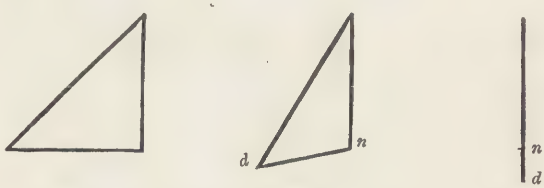
Third Position. *The model to be placed in a vertical plane at right angles to the last, the right angle of the model still remaining next to the class.*



Left. Middle. Right.

The next three positions to be similar to the three preceding with this exception, that the acute angle is to be placed nearest to the class, instead of the right angle.

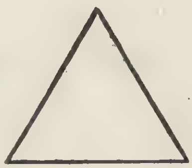
The model will afterwards be lowered so as to present the base of the triangle as nearly as possible on the level of the eyes of the majority of the class.

The model will afterwards be presented to the class with the base upwards, and the apex downwards, in three positions similar to those first described.

The diagrams and explanations are omitted here, as they are nearly the same as those given when treating of the simpler model of the right angle or the single straight line, by reference to which the teacher will see the course that may be followed, and the explanations that may be given.

Definitions.

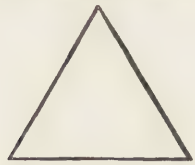
An *equilateral* or *equal-sided* triangle is that which has all its sides equal.



An *isosceles* triangle is that which has two of its sides equal.

A *scalene* triangle is that which has the three sides unequal.

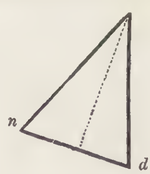
MODEL. AN EQUILATERAL TRIANGLE.



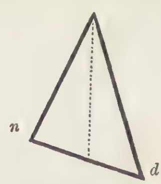
The principles that determine the apparent inclination, and amount of foreshortening of lines, have been so often referred to in the explanations of the appearances presented by the foregoing models, that it will be needless to repeat them here as applicable to the triangle, although the teacher will, of course, refer to them when presenting the model to the class. Our remarks on the above model will be confined to certain directions that will facilitate materially the proper representation of the figure.

There is little probability that any error will be committed in applying the proper principles to the foreshortening, or to the apparent inclination of the base, but (unless previously cautioned against the error) the pupils would be generally liable to throw the apex of the triangle out of its proper position, raising it at right angles, or nearly so, to the *inclined* direction of the base, whereas it

Triangle viewed obliquely and from below.



Probable Error.



Correct Representation.

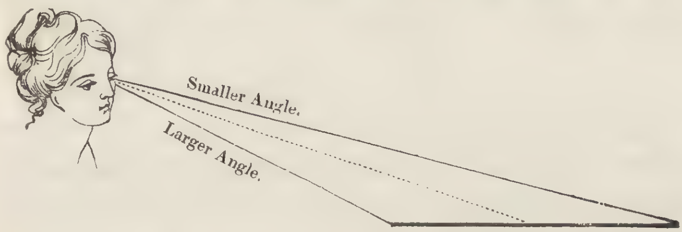
should, from all the varied points of view, be in a vertical line passing through the perspective representation of the middle of the base.

The following illustrations and demonstrations are

required for the due intelligence of the appearance of this model.

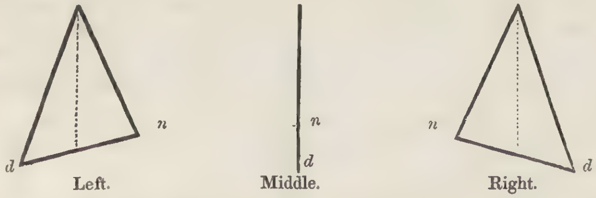
The teacher will hold a straight wire in a vertical direction passing through the apex of the triangle, and show that when so placed, it cuts or intersects the base exactly midway; but as a vertical line appears vertical, the apex evidently appears vertically above the middle of the base, and is therefore to be represented vertically above that point in the drawing which corresponds to the middle of the base.

Now, as the base is placed obliquely to all the members of the class, that central point of the base will not



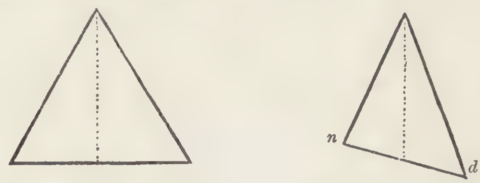
be *exactly* in the middle of the line representing the base, because the distant half of the base being further removed from the eye, forms at the eye a smaller visual angle than the nearer half of the base.

First Position. *The model in a vertical plane, parallel to the sides of the room, with the base horizontal, and above the level of the eye.*



The process for drawing the model will be as follows:—to commence with the base, which is to be properly foreshortened and inclined, and to raise from a point near the

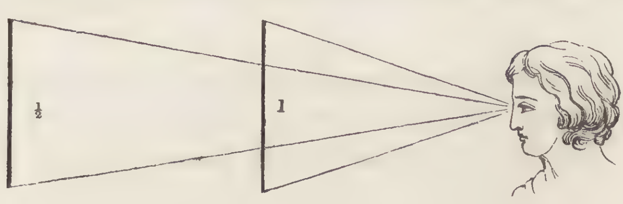
centre of the line so drawn an imaginary vertical line, to be called a *line of construction*, (which line is to be merely dotted); and, having determined on the relative height and width of the figure, to mark the proper height on this imaginary dotted line: the figure is then completed by simply joining the point in question with the extremities of the base. The triangle, instead of appearing equilateral, will appear as a scalene triangle.



Geometrical Representation. Perspective Representation.

The teacher need not hesitate to dwell on the demonstration which proves that the apex appears vertically above the middle of the base, as the error I have indicated is not uncommon, and because many familiar objects, such as the gable end of a house, or the upper segments of a gothic window, or similar forms viewed obliquely require, in their delineation, the application of this principle.

The teacher will also, from this stage forward, take occasional opportunities of explaining, and illustrating by means of the eye-model and straight wire, the simple method by which the comparative diminution due to distance may be estimated approximately; such as when two parallel and equal lines are so placed with reference to the eye, that one is twice as far from it as the other, the distant line will



appear half as long nearly as the first*. If placed one-fourth part further, (*i.e.* the distance being as 3 to 4,) it would,

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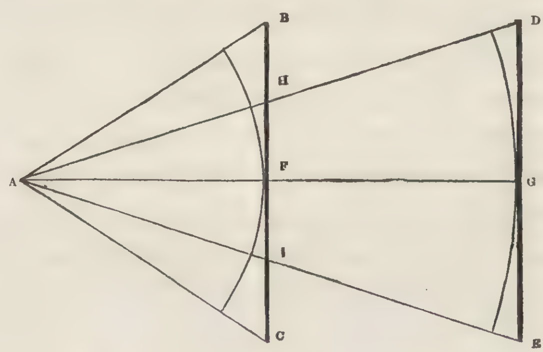
* For practical purposes it is sufficiently near to the truth to assume the apparent magnitudes to vary inversely in the ratio of the distances, especially when the visual angles, as recommended in page 120, when describing the proper distance from which objects should be viewed, are less than about thirty degrees.

That the apparent magnitudes do not vary in the inverse ratio of the distances is demonstrated as follows:

Let B C, D E be two equal and parallel lines, so placed with reference to an eye at A, that the perpendicular A G is double of A F, the angle B A C is not double of the angle D A E. For, by similar triangles (Euc. 6. VI.),

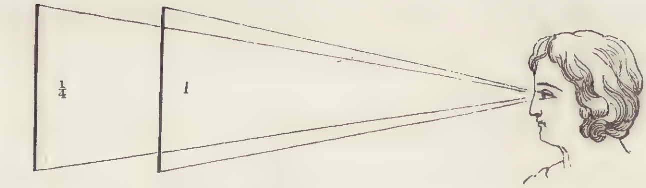
$$\text{AF} : \text{AG} :: \text{FH} : \text{GD}, \text{ but}$$
$$\text{AG} = 2\,\text{AF}, \text{ therefore}$$
$$\text{GD} = \text{BF} = 2\,\text{FH}.$$

Consequently, B F is bisected in H; and, therefore, as shown in note, page 53, the angle B A H is smaller than the angle F A H; in other words, the angle F A H is larger than half the angle B A F.

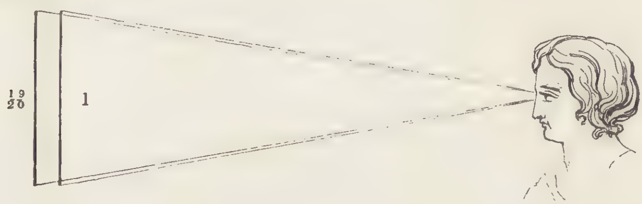


In the same manner it may be shown that the angle F A I is larger than half the angle C A F. Combining the two results, we find that the angle H A I is larger than half the angle B A C, but H A I is the visual angle subtended by D E at A; the line D E therefore appears greater than half B C.

This demonstration shows that the magnitudes vary exactly



appear about one-fourth less,—in other words, the distant line would appear about three-fourths of the near line. If placed one-twentieth part only of the distance further off, it would appear only one-twentieth part shorter nearly, and so on.



The relation of the visual angles is thus found by a simple arithmetical operation with all the necessary accuracy for practice; and, indeed, were the common way adopted of determining the relations of these lengths, (see Chapter XV. on Geometrical Perspective,) by means of vanishing lines, this process would necessarily be approximative also, as the distance of the object would, in both cases, be estimated. Moreover, the class room might not unfrequently be too small to obtain the position of the vanishing points which would, in certain positions of the models, extend beyond its limits.

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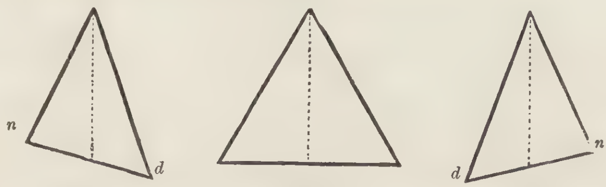
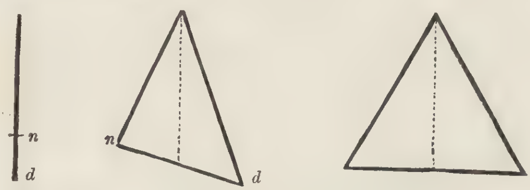
in the inverse ratio of the tangents of the visual angles which they subtend; and as, in the case of small angles, the difference between the arcs and their tangents is small, the ratio of variation being assumed to vary inversely as the distance will give results sufficiently correct for practical application.

Second Position. *The model as before in a vertical plane, but at right angles to the last position.*



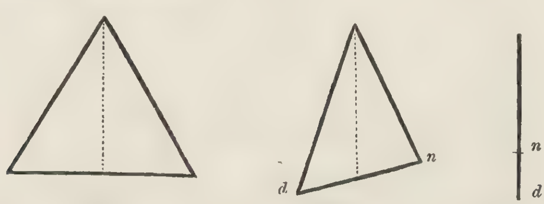
Left. Middle. Right.

Third Position. *The model in a vertical plane, at half a right angle to the last position.*



Left. Middle. Right.

Fourth Position. *The model in a vertical plane, at right angles to the last position.*



Left. Middle. Right.

In the above diagrams the dotted lines show the imaginary central line which is to be used in each figure as a guide in the determination of the position of the apex.

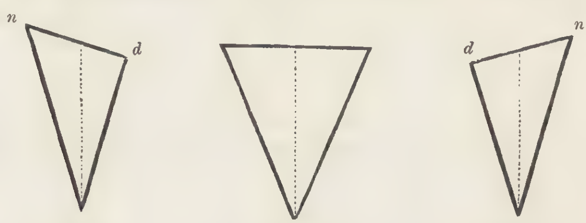
Model.

An Isosceles Triangle.

This model does not present any exercise varying from those which might be offered by the equilateral triangle: it is adopted partly to engage the attention of young pupils by a change of model, and partly to give, by immediate comparison, an exact knowledge of the different forms of triangles.

First Position. *The model in a vertical plane, parallel to the head of the room, with the base horizontal, but at the top of the figure, and the apex beneath: the model above the level of the eye.*

This, presenting exercises similar in principle to the preceding, it is only required to observe here, that the teacher will, as



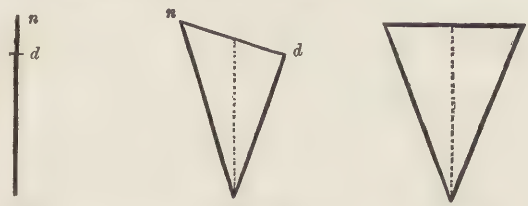
Left. Middle. Right.

before, direct the pupils to avail themselves of the central vertical line to determine the position of the apex, with reference to the upper line in the triangle.

Second Position. *All other things being the same, the model to be at right angles to the last position.*

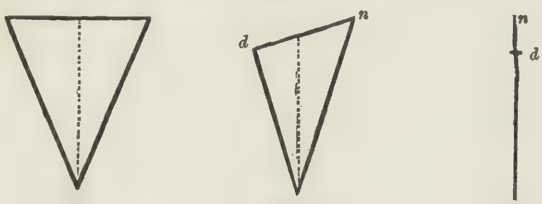
Left. Middle. Right.

Third Position. *All other things being the same, the model to be at half a right angle to the last position.*



Left. Middle. Right.

Fourth Position. *All other things being the same, the model to be at right angles to the last position.*



Left. Middle. Right.

Chapter VII.

PRINCIPLES OF PERSPECTIVE.

The next model in the series is the square, but as its representation involves a consideration of important optical effects that have not yet been considered, although they follow directly from the principles previously laid down, these effects must be explained before the pupils can be qualified to represent the square in perspective.

Appearances of Drawings alter with Change of Position.

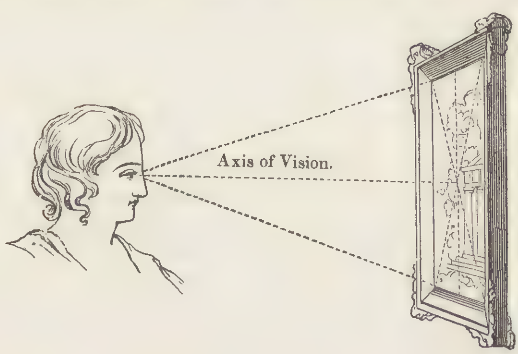
We have defined the art of drawing as having for its aim the delineation of objects, in such a manner that the representation shall convey to the mind a correct idea of the real form. All the preceding exercises and demonstrations have combined to prove, that, without any exception, change of position of the eye with reference to an object alters the apparent form of the object: it is manifest, therefore, that a picture viewed from different points of view presents different appearances; for, were it otherwise, an exception would have to be made in the laws of vision in as far as they relate to a picture only, which is contrary to common sense.

Position of the Eye with reference to the Drawing should be determined.

This being established, it follows that, in order that the drawing may fulfil the object set forth in the preceding definition, a certain position of the eye with reference to the drawing must be determined; and according to the greater or less deviation from that position, so will the drawing fail more or less to convey to the mind the idea required.

Picture or Drawing supposed to be in an Upright Position.

A convenient and very general way of looking at pictures or drawings is with the axis of vision directed towards the middle part of the picture, the picture itself being in a vertical position. As the

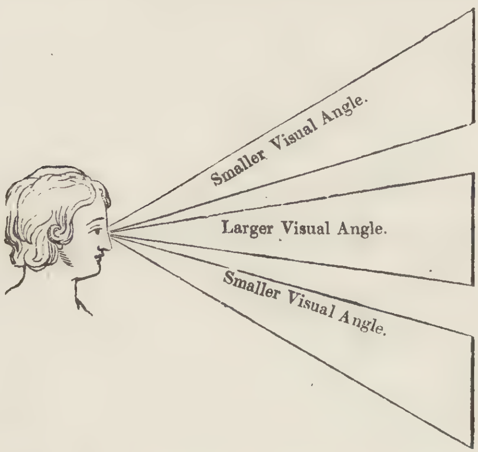


position to be occupied by the picture with reference to the eye is arbitrarily determined, the above position has been generally assumed as the most convenient. The drawing is therefore to be made

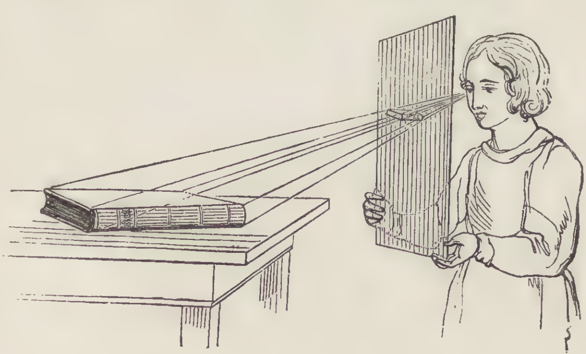
on the assumption that it is to be examined in such an upright position.

Drawing supposed to be interposed between the Eye and the Object represented.

But this is not in itself sufficient; for, retaining the drawing in a vertical plane, its appearance as a whole, or the visual angles which each of its parts would form at the eye, would be altered according



as it might be viewed from above or below, or on the level of the eye. The exact position of the



picture is therefore to be further determined by assuming that it is to occupy, with reference to the eye, a position such as that which would be given to a transparent plane of glass, *interposed* in an upright position between the eye of the spectator and the objects.

Drawing supposed to be placed Square to the Eye.

But again, such a plane of glass might be placed either obliquely or square between the eye and the object. The position must, therefore, be further determined; and, as no one, in looking at a picture, ever thinks of placing it sideways to the eye, the position will be lastly determined by adding that the picture shall be square to the eye,—in other words, that its sides shall be equally distant from the eye. For this reason we see that in picture galleries the paintings that are hung above the level of the eye are made to incline forwards from the wall at the top; and the higher they are placed the more they are inclined, the object being to place them as nearly as may be square to the rays of light passing from the middle of the picture to the eye of the observer,—in other words, square to the axis of vision directed to the picture. With reference to this subject it is only necessary to add, that all the rules of perspective set forth in this Manual are based further on the assumption that the picture or drawing is to be made on a *flat* surface, for of course a representation of the same object viewed from the same point of view would differ according as it was to be made

on a curved or a flat surface. This is only restating in other words, that the optical laws are equally applicable to lines or appearances of drawings as to lines or appearances of objects.

Limit to the Extent of Prospect embraced at One View.

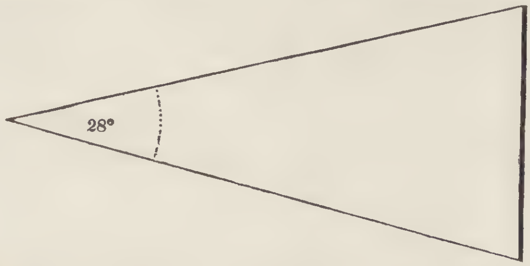
When the sense of vision is exercised, it is found that there is a limit to the extent of space, or the dimensions of a prospect embraced in the field of view, and that the head requires to be moved or turned to embrace a view of the objects beyond this limit. The boundary of the field of vision may be considered as circular, the power of distinct perception of objects extending equally in every direction measured from a common point. The draughtsman ought to have some knowledge of the extent of the natural field of view, in order that he may not attempt the representation of a prospect or of objects, the extreme limits of which could not be clearly seen without moving the head, an error into which inexperienced draughtsmen are very liable to fall.

Method of determining the Extent of the Field of Vision.

The following method of obtaining an idea of the extent of this field of view is simple and readily practised. If a spectator stand at an open window, with his head in a line with the front of the window, he will find that the scene presented to his view will be too extensive to be embraced at one glance, and that it will be necessary to turn his head from

side to side to obtain a view of the entire prospect. If he then retire gradually backwards into the room, continuing to look upon the scene without, he will find its extent to be gradually diminished and confined by the sides of the window, and that a certain distance from the window may be attained at which all the scene visible through the window may be clearly embraced without any turning of the head or disagreeable straining of the eye. If he mark and measure this distance from the window, and compare it with the width of the window itself, he will find the latter to be equal to about one-half of the former; that is, if the window be three feet wide, the distance in question would be about six feet; if the window be four feet wide, the distance would be about eight feet, and so on in proportion. We say about, because, this being a matter of feeling, no precise limit or distance can be laid down; however, without stating any empirical precept, it may be observed, that in general a distance from the object, varying to between two or three times its greatest dimension, will be found to present a pleasing picture, and that it will seldom be advisable to undertake the representation of any object or combination of objects from any position nearer than at least twice the greatest dimension of the object or combination of objects. The visual angle formed at the eye by an object placed at this minimum distance would be somewhat less than thirty degrees, or one-third of a right angle, and this may be assumed as the limit, beyond which the visual angle should

not be made to extend, because beyond the limits of this angle objects cannot be seen distinctly by direct vision without a painful straining of the eye.



A line bisecting, or dividing into two equal parts, this angle of vision, is called the axis of vision, and in looking at any object, or combination of objects, the eye is naturally directed, so that this axis of vision passes through the middle of the object, or of the combination of objects.

An important practical advantage is obtained by assuming about one-third of a right angle as the limit of the angle of vision to be subtended by the picture. Unpleasing distortion is thereby avoided: globes, for example, represented towards the edges of the picture would (with the above limit) be bounded practically by circles; whereas, if the width of the picture subtended an angle of 90°, as is sometimes recommended, the perspective representation of globes at the edges of the picture would be ellipses very sensibly marked, (formed by the intersection of a right cone with a plane not parallel to its base,) and such representations, although correct in theory, and true in appearance when viewed exactly from the proper point of sight, would

be unpleasing if examined from any other but the precise point of view required.

Moreover, as all optical laws which are applicable to the appearance of objects generally are of course applicable to the appearance of a picture or drawing, no drawing or picture should be drawn so as to render it necessary that it be examined from a point of view nearer than at least twice the greatest dimension of the picture*.

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* Many authors of Treatises on Perspective have, notwithstanding their great skill as mathematicians, misled artists by their diagrams, which are made to appear distorted, and, therefore, untrue, although they have strictly followed geometrical principles. The reason of this is, that they have conceived their representations from points of view very dissimilar to those which ought to be selected by the draughtsman. They almost invariably place the spectator at an improper distance from the picture and the object, causing him to view the picture or the objects with a visual angle of 90° or more, which cannot be done without moving the head. The reason of this may have been, either owing to the authors not having applied their perspective knowledge to the frequent representation of actual forms, or for the sake of including within the compass of a small plate or drawing all the vanishing points; but whatever the cause, the effect is a distorted representation of the object, which offends the eye of all, but most of the cultivated painter, and leads to the conclusion occasionally stated, that the science of perspective is not perfectly true to Nature.

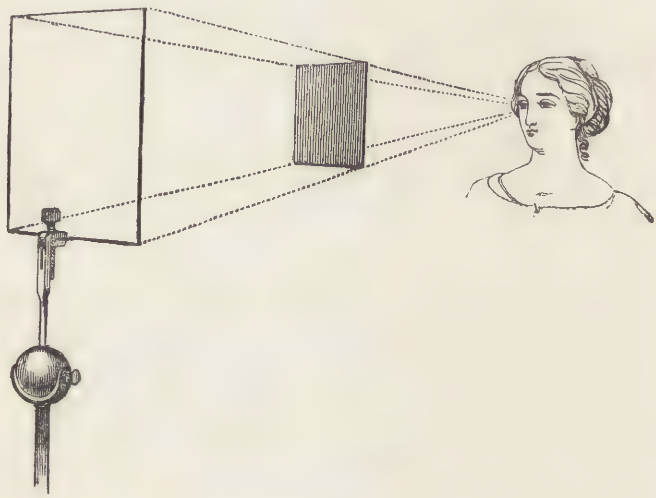
Representation of Lines parallel to the Picture.

We now come to a consideration of the manner in which lines parallel to the picture are to be represented.

Upright or vertical lines, being parallel, do not *appear* parallel. The visual angle formed by their width (or their distance asunder) at that part nearest to the eye, is greater than the visual angle formed by their width at any part further removed from the eye; consequently, that part of upright or vertical lines which is furthest from the eye appears narrowest. This effect, as was observed in Chapter IV., is made sensible in the inspection of a very high tower, or a deep well which is of the same diameter throughout. Nevertheless, when vertical lines are to be drawn on a flat surface, they are to be drawn vertical, *i. e.*, parallel to each other, for the following reason, that the apparent distance between the lines is reduced in the same proportion in the picture as in the object itself, the picture occupying, with reference to the eye, a position similar to that of the object.

To make this manifest, the teacher places the square (wire model) in a vertical plane, with the base horizontal, and having fastened threads at each corner, he draws these threads into a point representing the position of the eye. He then applies to these threads a small square (about one-fourth of the first) cut out of paste-board, in a vertical

plane, which square would represent the position of the picture, the boundary lines of the paste-board representing the drawing of the square. A simple inspection will demonstrate that the visual angles from the picture and from the object are identical.



Again, horizontal straight lines, parallel, therefore, to each other, do not *appear* parallel, but seem to approach closer to each other as they recede from the eye. But if these horizontal lines be square opposite to the eye, or, in other words, parallel to the picture (or plane of the picture), they will be drawn parallel, although as they increase in length, or are extended on either side from the axis of vision, their distance or width asunder necessarily forms at the eye a smaller visual angle; but, as we have said, they will nevertheless be drawn parallel on the flat surface of the picture, because the

apparent distance between the lines is reduced on the picture in the same proportion as in the object itself, the picture occupying, with reference to the eye, a position similar to that of the object.

To make this manifest, the teacher avails himself of the same illustration as for the vertical lines, to prove that the visual angle formed by the picture is the same as the visual angle formed by the object itself.

In the same manner the teacher will show, by moving the square frame in a vertical plane, so that the base of the square shall be inclined to the horizon, that whatever direction any parallel lines may have, whether vertical, horizontal, or inclined to the horizon, they will be drawn parallel to each other, when they are themselves square to the eye, or parallel to the plane of the picture.

But as it is of great importance that this should be clearly understood, and readily granted by the pupils, the teacher will further illustrate it by the following contrivance. He will make on the black board, placed in a vertical position, a drawing of the square, with its sides vertical, exactly of the same size as the model of the square. Placing this drawing above the level of the eye, he will cover it exactly with the wire-model, and asking whether the width between the vertical lines appears the same throughout their length, he will be told that the visual angle formed by the width at top is less than the visual angle formed by the width at

bottom. Next, removing the model so as to allow its representation, that is, its drawing, to be seen, he will ask the same question with respect to the apparent width or distance asunder of the vertical lines, to which the same answer would necessarily be given, for the mere fact of the one square being made of solid wire, and the other represented by white lines, can make no change in the optical laws which regulate their appearance. If the copy or drawing be made on a smaller scale, but in the same proportions, the same effect will take place in the reduced proportion.

A similar illustration may, if required, be given as regards the horizontal lines, and any other lines parallel to each other and to the picture.

From the above considerations the following most important general rule is deduced:

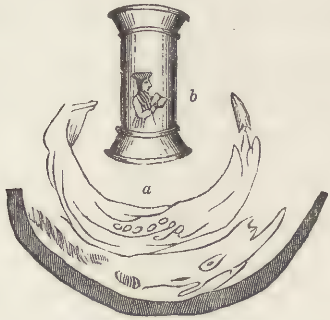
All lines parallel to the picture, i. e., situated in a vertical plane, are drawn parallel: and their real directions and their directions on the drawing are the same.

Distinction made between the Appearance of Objects and their Representation on a Flat Surface.

The consideration of the question of the proper perspective representation of lines parallel to the plane of the picture, has led some to suppose that the actual appearance of objects and their representation could not be reconciled, and even to conclude that natural and mathematical perspective

were contradictory. To those who look upon mathematical truths as immutable, such a proposition naturally appears startling; but a slight consideration will show that the erroneous conclusion is the result of the want of a clear understanding of that which is meant by a perspective representation. Drawing should not be defined as having for its aim to make a representation of objects *as they appear to the eye*, but as aiming at producing such a representation that it *shall convey to the eye the image of the object itself*. This distinction is indispensable, for a drawing made on a flat surface will present a different appearance if that surface be curved or bent, and different directions would, in that case, have to be given to the lines in order to produce the effect required. This follows necessarily from the optical laws which regulate either the foreshortening or apparent directions of lines. We may cite, as an illustration, those philosophical toys in which images apparently distorted and devoid of meaning when viewed in the manner in which drawings are usually inspected, are found to assume a regular and consistent appearance when seen from a particular point of view. Of the same nature, and depending on the same laws of vision, is an apparatus consisting of a cylindrical mirror and a series of distorted figures, which, when seen by direct vision, have neither shape nor meaning, but when laid before the mirror and seen by reflected rays, present images in perfect proportions. Thus, in the annexed diagram, (from BREWSTER'S *Optics*,) *a* is a distorted figure

whose image in the mirror *b* has the appearance of a regular portrait.



Objects can be represented as they appear to the eye only on the concave surface of a sphere, from the centre of which the representation should be viewed; a thing in itself impracticable, and not necessary, because the deception can be made as perfect on a plane surface.

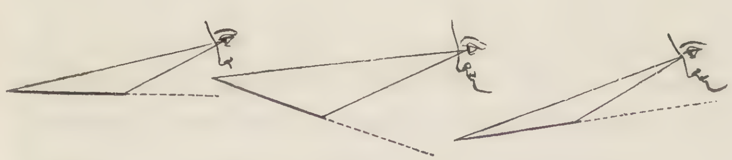
Remarks on the apparent Directions of Lines.

When examining the various conditions which influence the apparent directions of lines, we found that a change in their elevation with reference to the eye alters their apparent inclination. This proposition is true, whether the lines be horizontal or inclined, as may be shown by the following illustrations.

If the eye be below a line, or a line produced,

that line, whether it be actually level, or inclined upwards or downwards, will in all cases appear to incline or tend downwards.

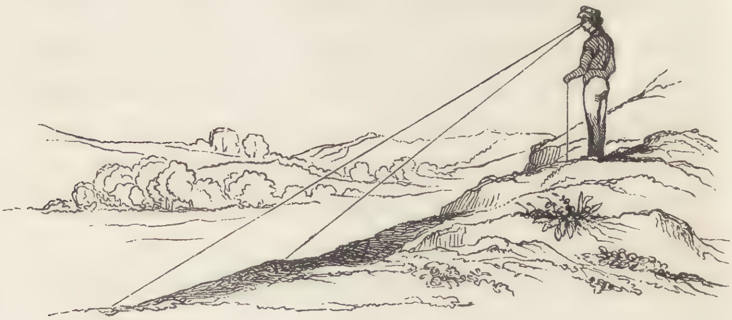
If the eye be above a line, or a line produced, that line, whether it be actually level, or inclined



upwards or downwards, will in all cases appear to rise or tend upwards.

The above illustrations, by which it is shown, for example, that the ray of light from the distant

extremity of a line inclined downwards from the spectator is actually higher in its course to the eye than the ray of light from the nearer, and conse-



quently higher extremity, may at the first consideration appear paradoxical: however, the evident fact that the ray of light from the distant extremity is higher in its course leaves no doubt on the subject.

Difficulty of representing a Plane inclining downwards from the Spectator's Position.

In consequence of this law of vision it is exceedingly difficult to represent with forcible effect the appearance, for example, of a road inclining downwards from the position of the spectator. The appearance of this going down hill depends in nature on many auxiliaries; and, when it is sought to produce a similar effect in a drawing, it can be obtained only by a skilful adaptation of such auxiliaries: for instance, by showing only the upper part of figures, trees, &c., the lower parts being supposed to be hid by part of the road; by representing objects not far distant, over the roofs of

buildings in the foreground, an appearance which cannot obtain for a spectator walking on a level road; also, by showing the road decreasing more suddenly in width in the picture; whereas, to produce the opposite effect of a steep road rising abruptly from the position of the spectator, the road would be drawn nearly equal in width at each end.

However, as in the majority of examples to be presented to the class in the subsequent models, the leading lines to be represented are either vertical or horizontal, and as it is advisable to refer all lines in direction to these more definite positions, we shall, when speaking of the apparent inclination of lines as caused by a change of position of the spectator, be understood as referring to horizontal lines, and the position of the eye will be determined simply by stating that the line or model is above, below, or on the same level with the eye.

The pupils, knowing that when the eye is on the same level as a line, that line appears level, and that according as the eye is placed above or below the line so will the line seem to incline upwards or downwards from the nearest point, will naturally conclude that the more nearly a line approaches to the level of the eye the less will be the difference between its true and apparent direction. As it is, however, of essential importance that the pupil should become thoroughly possessed of the truth of this proposition, the teacher will illustrate it by referring to the model of the eye, and the threads stretched to it from a straight wire.

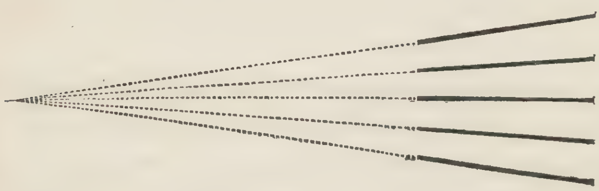
Effect of Difference of Elevation on the Apparent Direction of Lines.

If a horizontal line be held in the same vertical plane (or nearly so) with the eye, and elevated above the eye a given quantity (say two feet), the difference of elevation, or the separation between the two rays of light, will be clearly marked. Let then the wire

be lowered in a direction parallel to itself, and placed only half a foot above the eye, the difference of elevation, or the separation between the two rays of light, will be less prominently marked than in the first instance; the apparent difference of elevation therefore between the extremities of the line would be less in the second than in the first position.

Hence is drawn the conclusion, that of two or more lines equal in length to each other, and placed one above another in parallel directions, all of them being above the level of the eye, the lower line will appear to incline downwards from the nearest point by a less quantity than the line above it, and so on in succession, the highest line appearing to incline most. This effect will be noticed in looking at the

front of a long row of houses receding from the eye in which the line, marking the lower boundary of the roof, will appear to incline more than the line marking the sills of the upper row of windows; this again will seem to incline more than the sills of the windows next below, and so on in succession, each horizontal line in the front of the houses appearing to incline less than a line above, and more than a line below, until that particular line, which is on the same level with the eye, will appear horizontal. Below this level line, the lines will appear to rise or tend upwards from the nearest point, each line placed below the eye appearing to tend upwards less rapidly than a line at a lower level, and more rapidly than a line at a higher level, the lowest line of all appearing to tend upwards most rapidly. This effect is at

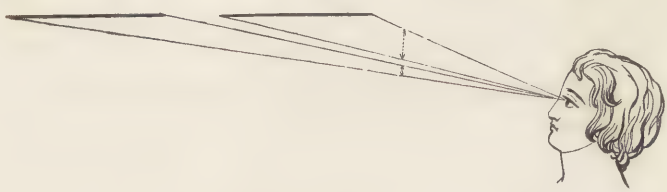


once described, by saying that *all the lines which are parallel to each other in the object observed, appear as they recede from the eye to tend or converge towards the same point; and if the lines be horizontal, that point will be on the same level with the eye.*

Effect of Difference of Distance on the Apparent Direction of Lines.

Secondly, the distance from the eye of a line placed either above or below the line has an influence on the amount of change in the apparent direction.

For taking, as before, a horizontal line placed at an elevation of two feet above the eye, with its near extremity only two feet distant from the eye, it will be found that the difference of elevation, or the distance between the extreme rays, will be greater than when the line is removed four feet from the



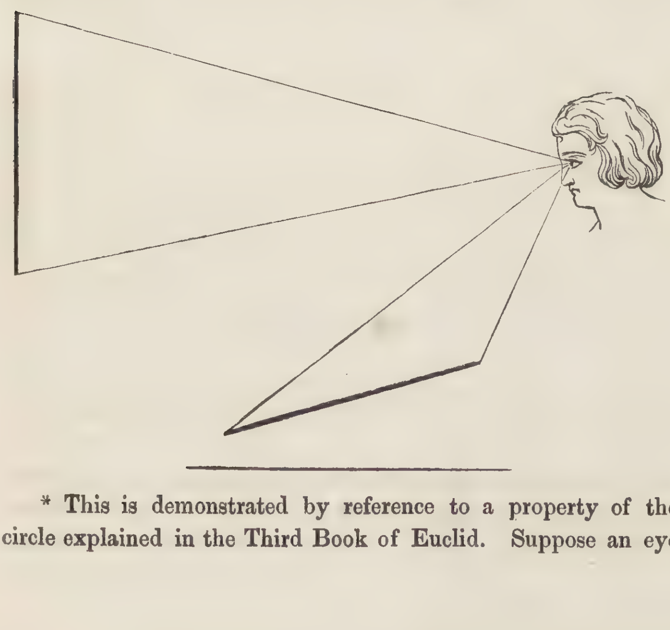
eye, the same elevation being retained; and the farther the line would be removed from the eye, the less manifest would the apparent difference of elevation, or the separation between its extreme points, become. In general terms, it may therefore be stated, that *the greater the distance the less is the effect produced by change of position in the eye with reference to the apparent direction of the lines.*

The above considerations show, therefore, that distance from the eye, and elevation as regards the position of the eye, combine to modify the apparent inclination of lines.

Effect of Distance, and Obliquity combined, on the Apparent Length of Lines.

It will also be found that distance from the eye, and comparative obliquity to the eye, combine to modify the apparent foreshortening or diminution of lines, as is shown thus.

We know that a line placed obliquely towards the eye appears foreshortened; in other words, that it forms at the eye a smaller visual angle than when it is placed, at the same distance, square opposite to the eye. On the other hand, we know that the farther a line is removed from the eye the shorter it appears. It may happen that these two effects would be so combined as to make a line seen obliquely appear either equal to, or longer than, an equal line seen in front but at a greater distance*,



* This is demonstrated by reference to a property of the circle explained in the Third Book of Euclid. Suppose an eye

the distance being such as to compensate for the greater visual angle which it would otherwise subtend.

These last considerations tending to show that distance has so material an influence on the appearance of objects, and consequently on their representation, we conclude that the distance from the object is to be so chosen that it may look agreeable, and in this selection the directions given in page 120, will be found a useful guide, and will guard against the effects of what is termed violent or sudden perspective. "The rules of perspective, as well as all

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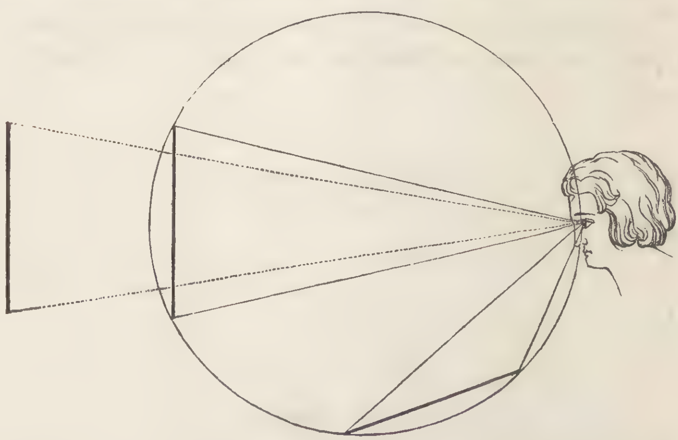
to be placed in the circumference of a circle, on different parts of which rest two equal chords, one viewed obliquely, and therefore foreshortened, the other at right angles to the axis



of vision. Both the visual angles are equal, being in equal segments of the circle (Euc. 21, III.): both lines, therefore, appear equal in length. And if the line placed square to the eye be removed without the circle, the visual angle which it would subtend would be smaller than that subtended by the line viewed obliquely, the first would therefore appear shorter than the last.

other rules, may be injudiciously applied; and it must be acknowledged that a misapplication of them is but too frequently found even in the works of the most considerable artists. It is not uncommon to see a figure on the foreground represented near twice the size of another which is supposed to be removed but a few feet behind it; this, though true according to rule, will appear monstrous. This error proceeds from placing the station of the observer too near the objects, by which means their diminution is so sudden as to appear unnatural, unless you stand so near the picture as the selected distance requires, which would be too near for the eye to comprehend the whole picture; whereas, if the station of the observer is removed so far as he may be supposed to stand, in order to see commodiously, and take within his view the whole, the figures behind would suffer under no such violent diminution*."

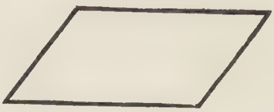
* Sir Joshua Reynolds, *On the Art of Painting*, Note 20.

Chapter VIII.

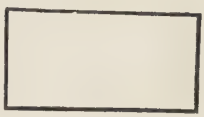
APPLICATION OF THE FOREGOING PRINCIPLES TO PRACTICE.

Definitions.

A *parallelogram* is a four-sided figure, in which the opposite sides are parallel.

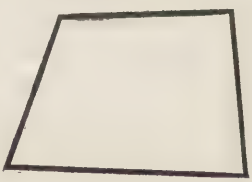


A *rectangle* is a right-angled parallelogram.



A *square* is a right-angled parallelogram, in which all the sides are equal.

A *trapezium* is any irregular four-sided figure of which the opposite sides are not parallel.



Model. A Square.

First Position. *The model in a vertical plane, parallel to the sides of the room, with the base horizontal, and above the level of the eye.*

It having been determined that vertical lines are always to be drawn vertical, they will in this case, as also for all subsequent models bounded by vertical lines, be drawn first, as presenting less difficulty than others.

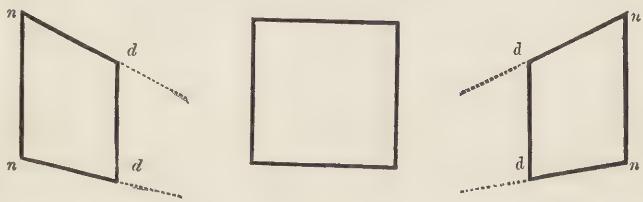
All the class see the width of the model diminished by the foreshortening of the horizontal lines, the diminution being greatest for those in the middle of the room; and if any pupils be in the same plane with the model, it will appear as a straight line.

Left. Middle. Right.

When the distant vertical line may be seen, it appears and is to be drawn shorter than the near line; this effect will be produced in the drawing by making the upper horizontal line incline more rapidly downwards than the lower horizontal line, by which means they will get closer as they recede from the eye, and consequently the distant vertical line bound by their intersections will be shorter than that which is nearer to the eye. The horizontal lines will have to be so drawn that, if produced, they would meet or converge in a point as much below the drawing, as the eye is below the model, supposing the drawing

and the model to be of the same size. If the drawing be less than the model, say of one-half its height, the point of convergence will be below the drawing by a quantity equal to one-half of the difference of elevation between the eye and the model; and so on in the same proportion.

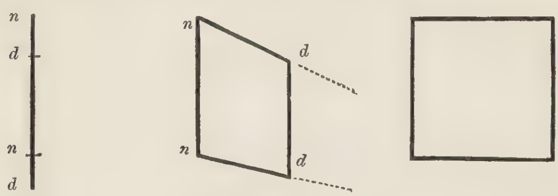
Second Position. *All other things being the same, the model to be in a vertical plane at right angles to the last, i. e., parallel to the head or upper side of the room.*



Left. Middle. Right.

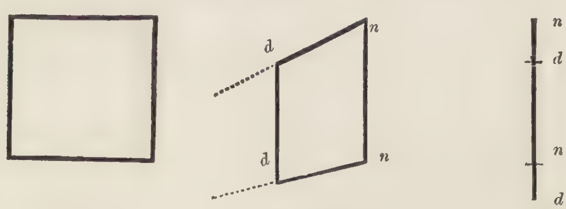
The model will appear narrower to those at the sides of the room, being drawn as a perfect square by those who may be exactly opposite.

Third Position. *All other things being the same, the model to be in a plane half a right angle to the last.*



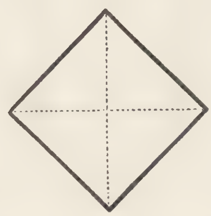
Left. Middle. Right.

Fourth Position. *All other things being the same, the model to be in a plane at right angles to the last.*



Left. Middle. Right

As this model illustrates several most important effects of perspective, we would recommend the teacher to cause it to be drawn from many points of view, until all can do so with success: for example, presenting it from the sides of the class-room, the model being otherwise in positions similar to those we have just described; also in similar positions, but at a considerably greater or less elevation; also placing one



of its diameters horizontally, retaining, however, the model in a vertical plane.

These and other exercises which are to be presented to the class as the teacher may think fit, will be useful in impressing on the pupils the necessity of causing all parallel lines (except when vertical or when square opposite the eye) to converge towards each other as they recede from the eye.

Chapter IX.

MECHANICAL AIDS IN PERSPECTIVE DRAWING.

Up to this stage of progress the pupil has derived no assistance from mechanical means in estimating the proportionate apparent magnitudes of different parts of the same model. His judgment alone has guided him in the application of the principles developed with respect to the foreshortening of lines, and their convergence towards a common point as they recede from the eye.

Now that the class may be supposed to be conversant with the principles, and prepared to commence the drawing of figures less simple in the arrangement of their parts, we shall describe ready methods by which each pupil may test the accuracy of his drawing, in as far as regards the relative magnitude of the parts and the inclination of the lines.

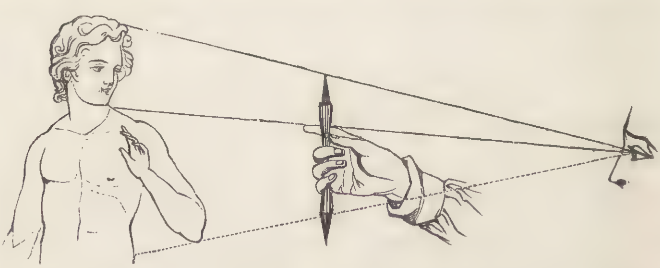
1. *To test the relative magnitude of the parts in the drawing.*

As previously explained, the rays of light, proceeding to the eye from the salient and characteristic points of an object, form at the eye angles of greater or less magnitude, depending, first, on the absolute length of the lines or diameters they subtend; secondly, on the greater or less distance of those lines or diameters from the eye; thirdly, on the

greater or less obliquity of the lines or diameters with reference to the eye. If, therefore, we can devise a ready means of measuring approximately, and of comparing the magnitude of those angles with respect to each other, we are thereby enabled to give to the representation of the object the proper proportion of the parts. To accomplish this, the student having determined on any two parts of the model, the apparent dimensions of which he is desirous of comparing together, selects for the unit of comparison the shorter of these dimensions with the view to ascertain how often it may be contained in the longer: the ideal measurement or comparison is then performed as follows.

Comparison of relative size of Visual Angles.

The chalk-holder is placed at arm's length, so that it may be kept with greater steadiness at a constant distance from the eye; and it is held in a vertical plane between the fingers, so that the



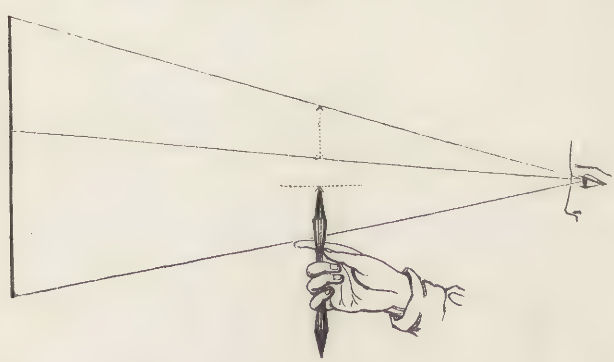
thumb can be made to move freely along it. One eye being shut, the porte-crayon is moved into such a position that it may hide from view, or seem to

coincide with, the direction of the apparent length to be measured; care being had to keep it always in a vertical plane square to the eye. The point of the crayon is then made (as shown in the diagram,) to meet the visual ray proceeding from one extremity of that length, or, as it were, brought into coincidence with the said extremity; the thumb is next moved from or towards the point of the porte-crayon until it is found to meet, or coincide with, the visual ray proceeding from the other extremity of the same length. The length of the porte-crayon thus marked off, being preserved by the thumb retaining its distance from the point, the porte-crayon is next moved into such a position that it shall hide from view, or coincide with, the second apparent length which is to be compared with the first. If the point of the crayon, and the place marked by the thumb, coincide with the visual rays proceeding from the extremities of this second length, then the two lengths are evidently equal. If they do not coincide, the comparison of the lengths is made in the same manner as a carpenter measures a line with a foot-rule, by starting from one extremity of the second length and marking by an ideal point on the model the place to which the portion of the porte-crayon seems to extend, this point is used as a second starting place, and the unit of measure is carried forward as often as may be necessary to embrace the entire length to be measured. When the portion of the porte-crayon, first marked off, is not contained an exact number

of times in the space to be measured by its means, its fractional parts, such as one-quarter, one-half, &c., are easily judged or estimated by the eye.

Illustrations of Method of Comparison.

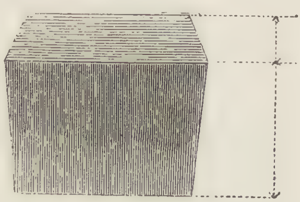
The above description of this process (as, indeed, descriptions of mechanical processes, when given in general terms, must always be to a certain extent,) is so long, that the class could not follow it easily if it were not at the same time illustrated by a simple example. This illustration the teacher will give by stretching, from the extremities of a vertical straight line, and from any intervening point, threads converging to one point representing the eye. He will then hold a chalk-holder, so that a portion of it may be intercepted between the upper and middle threads (or visual rays):—marking this portion with the thumb in the manner described, he will carry this as



a measure to be applied to ascertain the comparative size of the inferior angle, and will demonstrate to

the class, that if the wire be divided in the same proportion as in the annexed diagram, the measure obtained for the upper angle will fall short of the length required for the measure of the lower, which amount of deficiency the eye can easily estimate approximately.

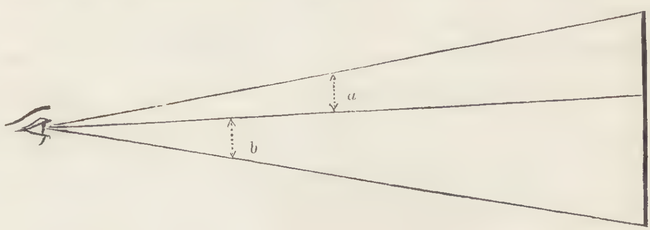
To give another example of the application of this method to the measurement of the relative apparent lengths of the parts of an object, the teacher will next place the cube before the class, in such a position that its upper and lower faces, deviating in some degree from the horizontal position, the upper face shall be seen by the class so foreshortened that its apparent



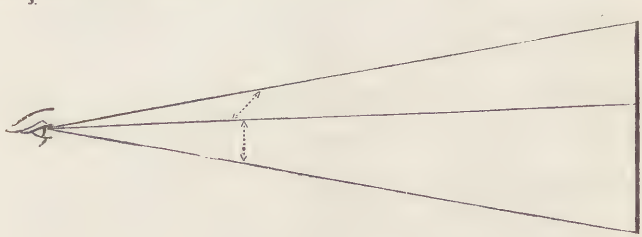
height will be about half of the apparent height of the face nearest to them. The pupils, then, by selecting the height of the upper side as the unit of measure or comparison, and marking off its length on the porte crayon held at arm's length as directed, will be enabled to estimate how often that measure is contained in the apparent height of the near face intersected at the same distance from the eye, and thence deduce the relative proportions to be given to the parts.

Precautions necessary in measuring Visual Angles.

It is further required, however, to show that this means of measurement is inapplicable, unless the chalk-holder, or whatever else may be interposed for the purpose between the object and the eye, be kept at a fixed distance from the eye, and also in the same vertical plane. This is easily shown by reference to the eye-model, and the threads disposed as before; for the line *a*, which measures the



smaller angle, may, if placed at *b*, nearer to the eye, extend beyond the threads or rays of light forming the larger angle; the process would therefore in this case be useless as a means of comparing the relative magnitude of the angles. It is manifest, also, that unless the line be in both positions retained in the same plane it is inapplicable to the purpose in view.



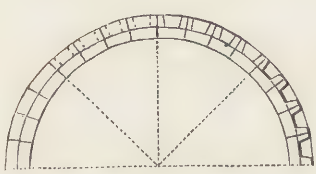
By this simple means the beginner is enabled to estimate approximately the degree of foreshortening in lines, an effect in which the greatest amount of optical deception concurs to mislead the learner.

The Draughtsman to proceed from the Whole to the Parts.

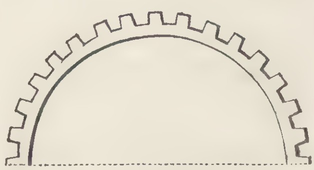
In drawing any figure or object composed of several distinct parts, the first operation consists in determining as above the extreme limits to be embraced by the figure in its greatest and least dimensions; the general outline of the exterior boundary is then traced, and the interior and more minute details are filled in at the last operation. A draughtsman who, without method, commences a drawing by tracing the detail before the general proportions are sketched out, must ncessarily fail in the result, owing to the great number of complicated relations which he endeavours to appreciate at one moment. Moreover, in drawing each line next to the adjoining one, he uses the first length or line drawn, as a kind of scale wherewith to estimate the dimension of each succeeding line; small errors in each estimation (and it is impossible to avoid them,) thus accumulate to so great a degree, that when the parts are grouped they are found very sensibly out of proportion. By commencing, on the contrary, with the great masses, such errors as may be made in the estimation of their proportions are subdivided in each minute detail, and mar in a less degree the general effect. The advantage of this method of

proceeding from the whole to the parts is sufficiently obvious; but as beginners are liable to fall into the erroneous system we deprecate, the teacher may illustrate its defects by an example.

If it were attempted, for instance, to draw a cog-wheel by placing each tooth or cog one by one in succession, finishing each part independently of the next, the most practised eye and skilful hand could scarcely produce a correct drawing of the whole; the parts would not be put properly together, and if a correction was found necessary, all the time and labour previously bestowed on the minutiæ would have been entirely thrown away. If, on the contrary, the draughtsman had commenced by drawing the circle which marks the circumference of the



In progress.



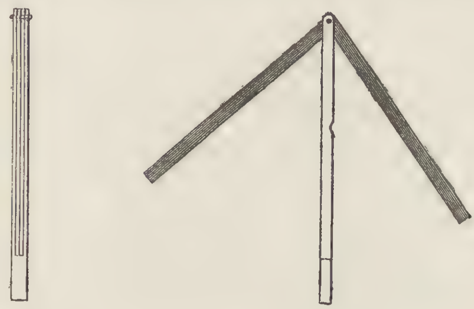
Finished.

wheel, and dividing it into four, or eight, or any number of symmetrical parts, to be afterwards subdivided by the insertion of each cog or tooth, a correct drawing would be finished with much greater ease and rapidity.

This principle should, therefore, be borne in mind, to work generally from the whole to the parts, rarely from the parts to the whole.

2. To estimate the apparent Inclination of Lines.

The Sight-rule. The annexed diagram represents a simple instrument well adapted for determining the apparent inclination of lines. The side arms revolve round a pivot at the upper part of the case, which is hollowed out to receive or inclose the side arms. These should revolve freely round,



Shut. Open for use.

but yet with sufficient stiffness to remain at any angle without shifting by their own weight.

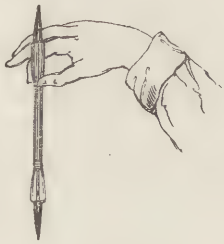
To determine, by the sight-rule, the apparent inclination of a line, the middle part or case is held upright between the eye and one extremity of the line; and one of the arms being moved up or down as required, is fixed at such an angle that its direction coincides with the apparent direction of the line to be drawn. The instrument being then laid flat on the drawing, with the middle part or case in a vertical direction, the inclination sought can be traced on the paper, or any error detected in a line previously drawn. When the object to be represented, a house for example, has any bounding line

vertical, the case, or middle part, is interposed between the eye and such vertical line until it seems to coincide with it; the side arms are then, as before, brought to such angles that they seem to agree in direction with the lines of the building, whose apparent inclination is sought; and the arms being fixed at those angles, any error in the inclination of the lines is easily pointed out in the drawing.

This instrument will be found to solve with rapidity and correctness every problem connected with the inclination of lines; but, as it may not be always at hand, we shall further describe a method by which the chalk-holder, or pencil used in the drawing, may be made available for the determination of the apparent inclination of lines.

First. As regards vertical lines, the porte-crayon may be used as a substitute for a plumb line, by holding it lightly from one end so as to let it fall by

its own weight in a vertical position; when thus suspended, if it be brought to intersect the line of



which the inclination is sought, the agreement of that line with the vertical, or its departure therefrom, may be estimated with tolerable accuracy.

Secondly. As regards horizontal lines, the porte-crayon is placed in a horizontal position by comparison with any horizontal line in the room, which is square opposite the eye, and when so held it is brought, square opposite to the eye, and so as to intersect the line whose horizontality, or departure therefrom, it is desired to estimate.

Thirdly. To estimate the apparent inclination of a line in any direction, the porte-crayon is held between the line and the eye, and moved upwards or downwards, or, in more precise terms, angularly in a vertical plane, until its edge appears to coincide with the line in question. The inclination thus given to the porte-crayon is evidently the same as the apparent inclination of the line, otherwise it would not interrupt the rays of light passing from the line to the eye.

Reason for not adopting these Mechanical Aids at an earlier Stage of the Course.

The above described mechanical aids in judging of the effects of perspective will evidently, from their easy application, greatly simplify the task of the teacher in correcting the drawings, as well as produce greater accuracy in the drawings themselves: it may therefore be asked why it has not been proposed to employ them at an earlier stage of the course. To this we answer, that the assistance they afford is so great that there would be a tendency in the pupils to trust to them alone, ceasing to refer to principles as their guide, and learning little, therefore, of the *rationale* of the science. But, at this stage of the course, it is conceived that the pupils will have become sufficiently masters of the principles to be safely entrusted with the application of these mechanical aids. Nevertheless, the teacher will continue to refer to principles for the purpose of correcting errors or explaining optical effects; and here we would take the opportunity of stating, that these mechanical aids are to be used more as a means of correcting errors than of executing the drawing from the first operation, did not experience prove that the difficulty with the pupils consists generally in inducing them to make a sufficient use of the assistance thus offered, with the view to make them in some measure independent of the teacher's aid, the majority generally endeavouring to execute

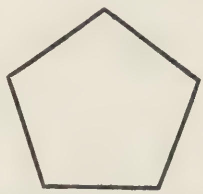
their drawing by the guidance of the eye only, assisted of course by the theory of perspective.

Simple as the above operations are, and easily understood as they may be, when their practical application is illustrated by the teacher before the class, experience has nevertheless shown that, for a certain small number of pupils in a class, individual explanation is required. The teacher will therefore take care to test, by individual examination and explanation, whether each and all of the pupils have understood the application of these mechanical appliances, and not to pass beyond this stage until all shall have become conversant with the process. The time thus bestowed will have been well spent.

Chapter X.

APPLICATION OF FOREGOING PRINCIPLES TO PRACTICE.

Model. The Pentagon.



A right-lined figure, composed of *five* equal sides.

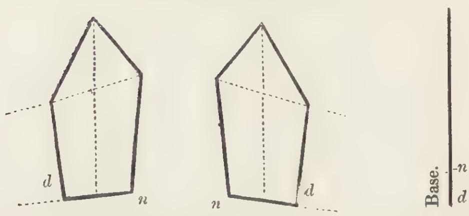
The positions of this model are to be varied in the same manner as the preceding figures, taking care that the model shall always be in a vertical plane, with its base in a horizontal position. It has been deemed sufficient to indicate, in the following diagrams, the general appearance of each model as viewed from certain specified positions, but the teacher will not necessarily confine the exercises, either as regards their number or the points of view, to those shown in the illustrations.

The dotted lines, or *lines of construction*, are to be used in assisting to draw the figure in perspective by referring its parts to vertical or horizontal lines. The teacher will in this, as in future instances of the same kind, apply a straight wire to the figure to represent those imaginary lines of construction. Whenever real or imaginary parallel lines, receding from the eye, are to be placed in perspective, the pupils will prolong them (as shown in the diagrams) beyond the limits of the figure, with the view to point out more clearly that, if produced far enough, they would all meet in one point. With every model of this

character, the teacher will refresh the memory of the pupils with regard to the apparent convergence of parallel lines that recede from the eye.

At right angles to the axis of vision.

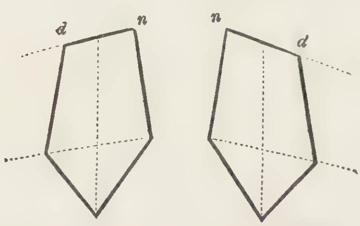
Base at bottom.



Above the level of the eye, and viewed obliquely.

In the same plane with the eye.

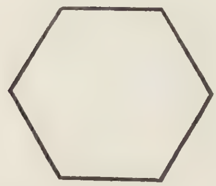
Base at top.



Above the level of the eye, and viewed obliquely.

In the same plane with the eye.

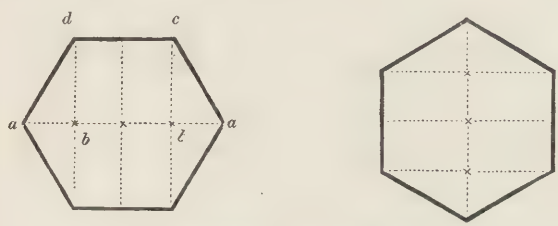
Model. The Hexagon.



A right-lined figure, composed of *six* equal sides.

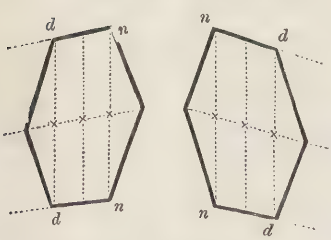
To be presented to the class, always in a vertical plane, and with one of its sides either horizontal or vertical.

The dotted lines indicate the lines of construction, to which the teacher will especially refer, for the purpose of pointing out that the distance *a b* is equal to half the length of the sides, *c d* for example.



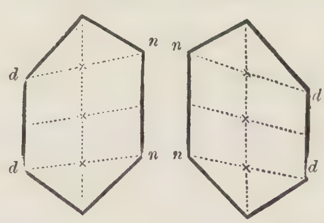
At right angles to the axis of vision.

Two sides horizontal.



Above the level of the eye, and viewed obliquely.

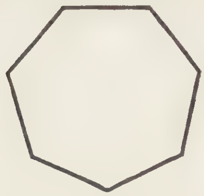
Two sides vertical.



Above the level of the eye, and viewed obliquely.

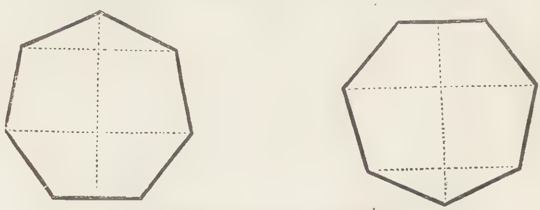
The perspective representations of the parallel lines, if produced far enough, should meet at one point.

Model. The Heptagon.



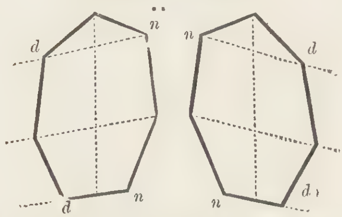
A right-lined figure, composed of *seven* equal sides.

To be presented to the class, always in a vertical plane, and with one of its sides horizontal. The dotted lines indicate the lines of construction, to which the teacher will refer.



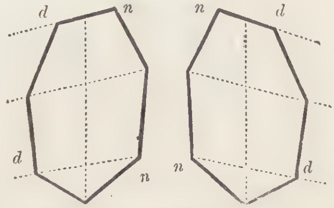
At right angles to the axis of vision.

Base at bottom.



Above the level of the eye, and viewed obliquely.

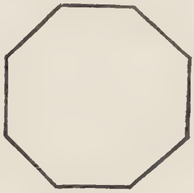
Base at top.



Above the level of the eye, and viewed obliquely.

The perspective representations of the parallel lines, if produced far enough, should meet at one point.

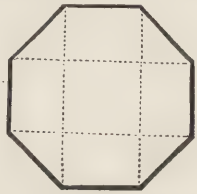
Model. The Octagon.



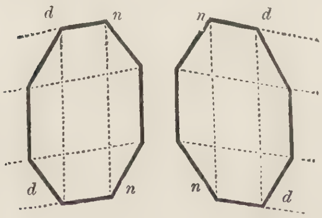
A right-lined figure, composed of *eight* equal sides.

To be presented to the class, always in a vertical plane, with one side horizontal.

The dotted lines indicate the lines of construction.



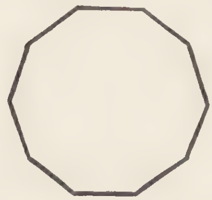
At right angles to the axis of vision.



Above the level of the eye, and viewed obliquely.

The perspective representations of the parallel lines, if produced far enough, should meet at one point.

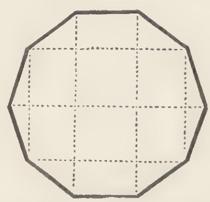
Model. The Decagon.



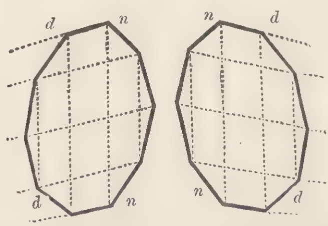
A right-lined figure, with *ten* equal sides.

To be presented to the class, always in a vertical plane, with one side horizontal.

The dotted lines indicate the lines of construction.



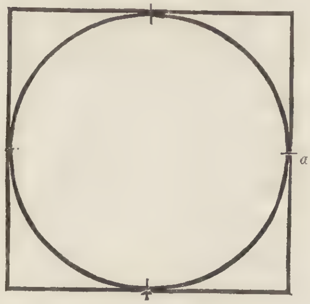
At right angles to the axis of vision.



Above the level of the eye, and viewed obliquely.

The perspective representations of the parallel lines, if produced far enough, should meet at one point.

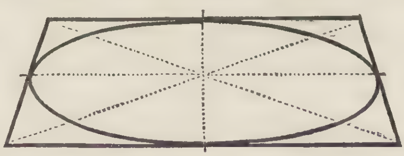
Model. The Circle and Square Combined.



First Series of Positions.

The circle being fixed by means of the pin *a* in the same vertical plane with the square, the combined model will be presented to the class in positions similar to those described for the square singly. These varied exercises will be useful in redirecting the attention of the pupils to the perspective representation of the square, a figure that cannot too often be presented to the class for the purpose of serving as a preparation to the representation of solid forms.

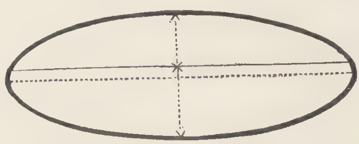
With reference to the delineation of the circle, the teacher will point out that as it touches the sides of the square in points midway between the angles, the perspective representation of the circle must necessarily (from whatever point of view it may be seen) pass through the perspective representation of the said



four points in the sides of the square. These four points will be sufficient to guide the eye and hand in the sweeping of the curve, which is to be drawn so that it shall not contain any harsh angular bend, and so that the curve shall be symmetrical, that is, that the parts on each side of a diameter shall be equal and similar.

The curve produced by a circle viewed obliquely is a perfect ellipse. The teacher will here show to the class the model of the ellipse, and keep it before their view throughout the whole of the exercises connected with the circle, in order to habituate the eye to judge of the kind of curve produced by the circle when viewed obliquely. The most common error in drawing the perspective representation of the circle consists in a want of fulness towards the extremities of the longer diameter or axis, making the curve too sharp or angular at those points. A comparison with the model of the ellipse will enable the pupils to avoid that error.

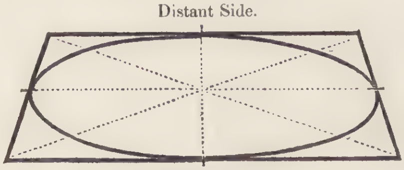
Although the figure produced by the oblique view of the circle is an ellipse, yet the part of the curve which represents the distant half of the circle is smaller than the part which represents the near half. The greatest width of the ellipse is not at that place which gives the perspective representation of



the diameter of the circle square opposite to the eye, (shown in the annexed figure by the hard line,) but is precisely at that diameter, shewn by the dotted line, which divides the ellipse geometrically into two equal parts.

The exact diminution of the distant half of the circle, as compared with the near half, is obtained by drawing the diagonals of the circumscribing square, as shown in the annexed figure, by which it will be seen that they intersect at a point nearer to the distant than to the near side.

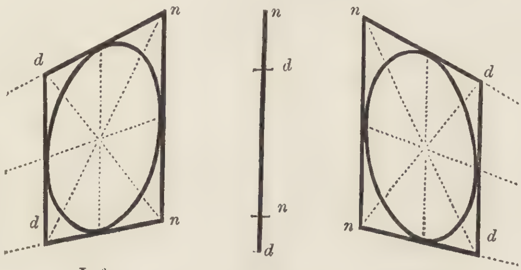
Distant Side.



Near Side.

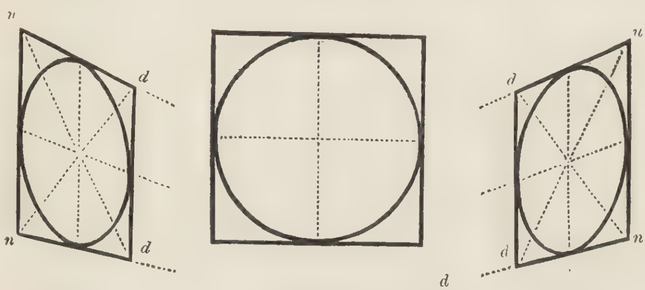
The teacher will direct the pupils to use the lines of construction as shown in the following figures:

First Position. *Model in a vertical plane, parallel to the sides of the room, and above the level of the eye.*



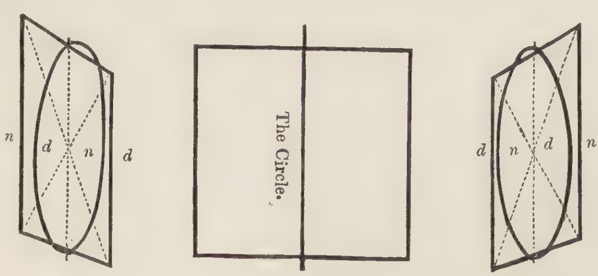
Left. Middle. Right.

Second Position. *In a vertical plane, at right angles to the last position.*



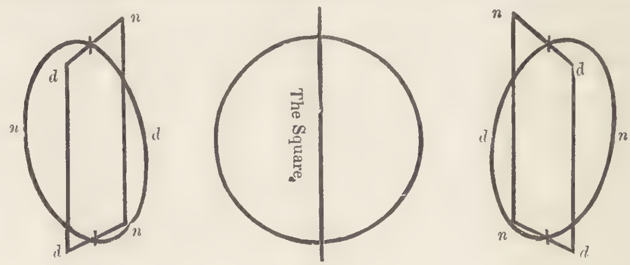
Left. Middle. Right.

Third Position. *The pin having been removed, the circle and the square are to be placed in two vertical planes at right angles to each other the circle being parallel to the sides of the room, and above the level of the eye.*



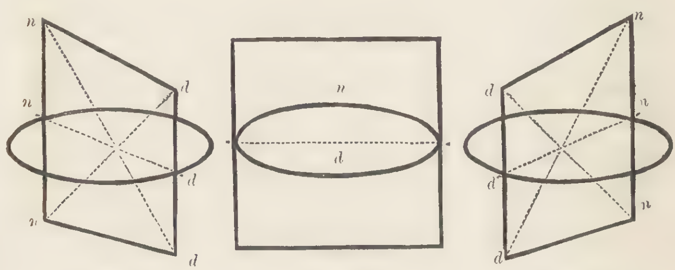
Left. Middle. Right.

Fourth Position. *The positions reversed; i.e. the square to be placed parallel to the sides of the room, instead of the circle as above.*



Left. Middle. Right.

Fifth Position. *The square parallel to the head of the room, in a vertical plane, and above the level of the eye. The revolving axis of the circle to be horizontal, and the circle to be placed in a horizontal plane.*



Left. Middle. Right.

When a circle, in a horizontal plane, is viewed obliquely, its greatest apparent diameter is always horizontal. The teacher will illustrate this by applying a straight wire to the circle so as to form a diameter square to the eye of any one member of the class; that diameter will represent the greatest apparent dimension of the circle, because being square to the eye it is in nowise foreshortened; also it will be horizontal, because horizontal lines square to the eye are drawn horizontal. This being shown to be true from whatever part of the room the circle is viewed, we conclude that the greatest dimension of a circle placed horizontally, and viewed obliquely, is to be horizontal in the drawing.

Model. The Circle.

The square being next separated from the circle, the circle is to be presented to the class singly, in various positions, provided it be always either in a vertical, or a horizontal plane.

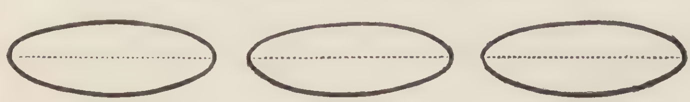
The straight lines which, in the last model, circumscribed the circle, were of considerable assistance in the delineation of the curve. Their removal renders that delineation more difficult, because more is left to be determined by the aid of the eye only. The drawing of a circle from any point of view will be facilitated, if the student bear in mind that the diameter of the circle which is square opposite the eye appears the longest, while the least apparent diameter is one at right angles to the first, being that which is most oblique to the eye.

We would remark that it is especially with figures of this kind, in which no salient points or prominent lines can assist the eye, that the student should apply the mechanical means we have described for comparing the relative magnitudes of the parts by means of an approximate measurement of the visual angles they form or subtend at the eye.

First Position. *The circle parallel to the head of the room, in a vertical plane, and above the level of the eye.*

Left. Middle. Right.

Second Position. *In a horizontal plane.*

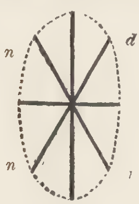


Left. Middle. Right.

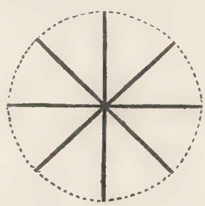
Model. A Star.

Although this model is composed of straight lines, yet it is introduced after the circle, because the proper way to proceed with its delineation is by the assistance of an imaginary circle passing through the extremities of each line, and whose centre is at the common point of intersection of the lines. Such an imaginary circle in this case is used as a line of construction.

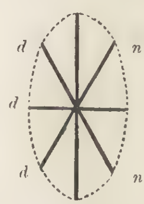
First Position. *On the level of the eye, and in a vertical plane parallel to the head of the room.*



Left.

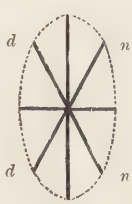


Middle.



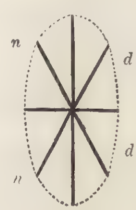
Right.

Second Position. *At right angles to the last position.*



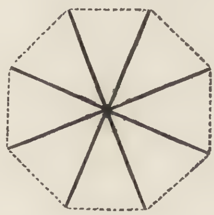
Left.

Middle.



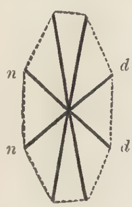
Right.

The octagon, or right-lined figure composed of eight equal sides, may, in a similar manner, be used as affording proper lines

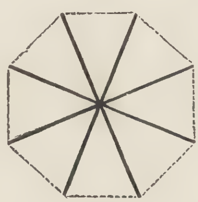


of construction to assist in the delineation of the model.

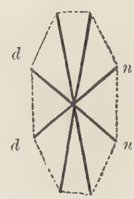
First Position. *On the level of the eye, and in a vertical plane parallel to the head of the room.*



Left.

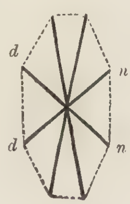


Middle.



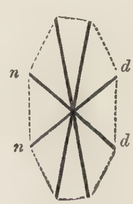
Right.

Second Position. *At right angles to the last position.*



Left.

Middle.

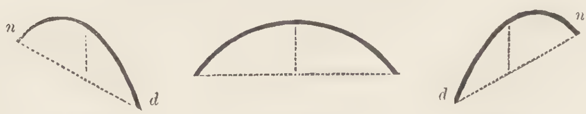


Right.

ADDITIONAL EXERCISES IN THE DRAWING OF CURVED LINES.

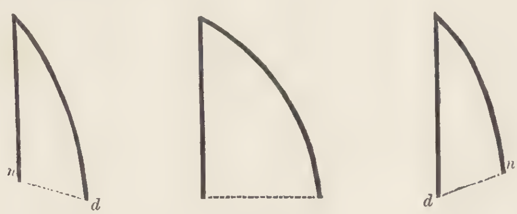
For the purpose of further exercising the hand and eye, in the drawing of various curves, the following series will be presented to the class, the pupils' attention being directed to the lines of construction as shown in the corresponding figures:

Arc of a Circle. Above the eye.



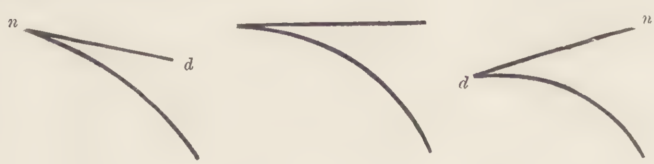
Left. Middle. Right.

Arc of a Circle and Secant, forming what is termed a Horned Angle. Above the eye.



Left. Middle. Right.

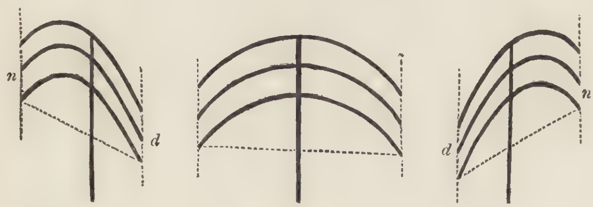
Arc of a Circle and Tangent, forming what is termed a Horned Angle. Above the eye.



Left. Middle. Right.

Three equal Arcs of a Circle, vertically equidistant from one another.

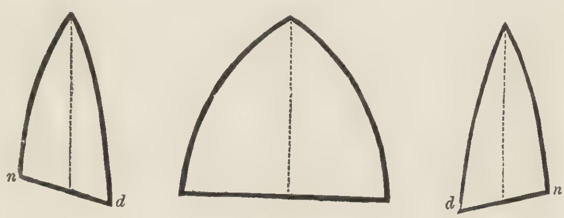
Above the eye.



Left. Middle. Right.

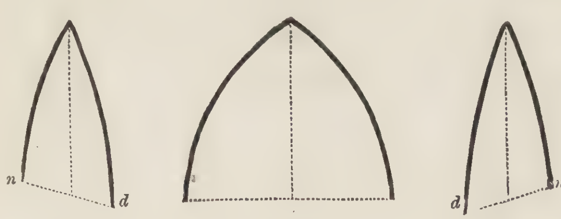
Two equal Arcs (Convex) bounded by a straight line.

Above the eye.



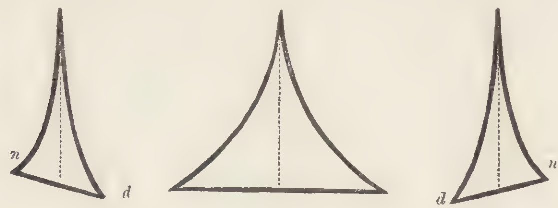
Left. Middle. Right.

The same as above, *without the straight line*, and therefore less definite, and a little more difficult to draw.



Left. Middle. Right.

Two equal Arcs (Concave) bounded by a straight line. Above the eye.

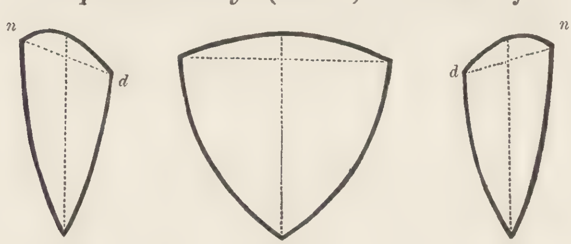


Left. Middle. Right.

The same as above, *without the straight line*, and therefore less definite, and a little more difficult to draw.

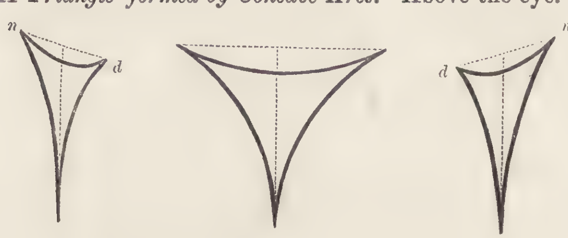
Left. Middle. Right.

A Spherical Triangle (Convex). Above the eye.



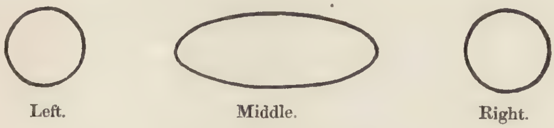
Left. Middle. Right.

A Triangle formed by Concave Arcs. Above the eye.



Left. Middle. Right.

Finally, *the Ellipse*, to be drawn from any point of view, and in any position, for the sake of further exercising the eye and hand in the judging and drawing of various curves.



Note.—Some geometricians have given to several of these latter figures names which define their form and character with greater precision than the phrases we have adopted for the same purpose. The rare use, however, which is made of those names, even in scientific works, renders it unnecessary that they should be known by students, while their novelty could only serve to perplex. For example, the model formed by two convex arcs intersecting each other might have been concisely and accurately defined as a cissoid angle; and the model formed by two concave arcs intersecting each other might have been defined as a pelecoid, or hatchet-like angle. The mention of these names will, however, be sufficient to show the expediency of rejecting them from the text, even at the sacrifice of a certain degree of precision and conciseness.

Chapter XI.

SOLID FORMS.

Unless when otherwise specified, it will be desirable to present the models of solids in some well-defined position, by placing their base in a horizontal plane. This is recommended, first, because the majority of natural or artificial objects are presented to our view in similar positions; secondly, because the foreshortening and apparent inclinations of lines can thereby be more directly referred to the principles previously set forth, and errors more easily made manifest to the learner's judgment.

A certain number of the series of solid forms, as shown hereafter, should first be drawn merely in outline on the slates.

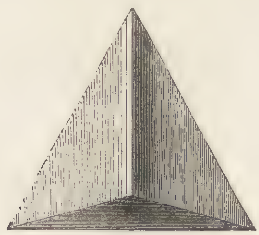
Definitions.

Regular Solids are those that are comprehended by regular and equal planes or surfaces.

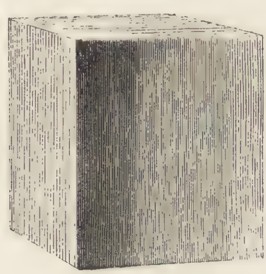
Irregular Solids are all such as do not come under the definition of regular ones.

The regular solids are five in number, viz.:

The *tetrahedron* *, or regular triangular pyramid, having four equilateral and equal triangular faces.

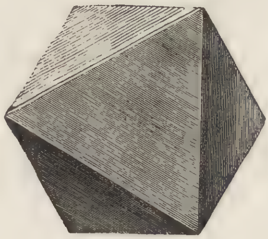


The *hexahedron*, or cube, having six equal square faces.

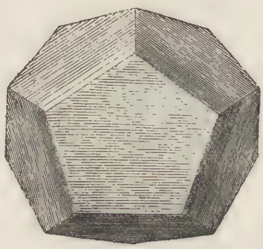


* The pupils (if young children, or others unaccustomed to the use of scientific terms,) should not be required to learn these names of the regular solids; nor is it even necessary that they should be mentioned to them. It will be sufficient to exhibit the models to the class, directing attention at the same time to the respective characteristic properties of each, so that the pupils, when required to draw them, may have a precise knowledge of their form. The object is to teach *things* much more than *words*.

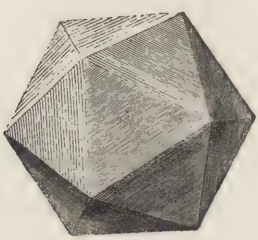
The *octahedron*, having eight equilateral and equal triangular faces.



The *dodecahedron*, having twelve equal pentagonal faces.



The *icosahedron*, having twenty equal triangular faces.



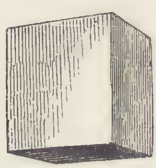
The *sphere* might be added to the above, as forming one among the regular solids.

The irregular solids are unlimited in number.

Model. The Cube.

To be placed above the level of the eye.

The teacher will direct attention to the component parts of the model, and show that if the square can be drawn singly in true perspective, its combined representations in the cube will offer little additional difficulty. Nevertheless, for the purpose of guarding against a very general error among beginners, of not foreshortening sufficiently those faces which are presented obliquely to the view, the teacher will place the wire model of the square in a horizontal position, above the level of the eye, and cause it to be drawn, directing attention, at the same time, to the convergence of the parallel lines as they recede from the eye.



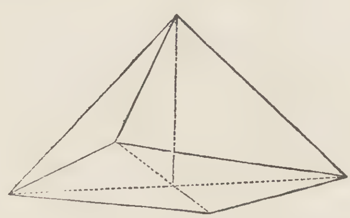
When this has been drawn, the wire-model will be left by the side of the cube to guide in the delineation of its base.

Delineation in outline of some of the succeeding Models in the series.

The solid forms embraced from No. 1 to No. 10 in the plates will be drawn in succession in simple outline. With respect to this part of the course we have the following observations to offer.

It would extend this Treatise to too great a bulk were we to attempt to show by diagrams the lines of construction to be used in the first outline sketch

of the solid forms. The application of such imaginary lines to the models previously drawn will, it is hoped, suffice to indicate to the teacher those which would be most advantageously applied to assist in the delineation of the forms that follow. In general terms we would say that bounding lines of surfaces should, if possible, be referred either to vertical or horizontal lines; and that in surfaces terminated by parallelograms the diagonals will generally be useful, either to fix the position of points or parts within such surfaces, or to determine the relative position of points on adjoining surfaces. For example, in the quadrangular pyramid, placed with its base hori-



zontal, and above the level of the eye, the diagonals of the square base, drawn in perspective, mark by their intersection a point vertically below the apex of the pyramid. The apex must, therefore, be placed in some part of the upright line raised through that point of intersection.

After the models enumerated above shall have been drawn in outline on the slate, the pupils will be sufficiently advanced to commence drawing on paper with firmness and truth. In doing so they will return to the cube, and proceed in succession

with the delineation of each model in the order shown in the plates. To prepare the pupils for this part of their exercises, it is necessary to describe the mode of operation on the paper, and to consider the effects of light and shade, with the view to deduce rules that may serve as general guides in practice.

PART THE SECOND.

LIGHT AND SHADE.

Chapter XII.

OF SHADED DRAWINGS.

Paper.

The paper used for shading should be tinted of a light colour, for the sake of its more pleasing effect on the eye, and because by its adoption some time is saved in the execution of the drawing by using the tint of the paper for the middle tints to be given in the representation. The most suitable tints are those approaching to a dull slate colour.

Stumps.

The shades are produced and the lights laid on with a stump, an instrument made of chamois leather, or soft paper rolled tightly into a cylindrical form, and cut at both ends to a point. Shading with the stump is recommended in preference to shading directly with the crayon, because of the greater freedom it imparts to the hand, the superior rapidity with which it gives execution to the conceptions of the artist; and also because the shades produced with it imitate more nearly the general appearance of the surfaces of the models, or of objects in nature, than the more artificial means of producing shades by hatchings. The latter, when used solely, require much greater time to produce

an equal degree of finish. Hatchings, however, independently of their being occasionally required to represent texture, or to convey the idea of particular materials, are useful in training the hand to precision and accuracy; we, therefore, as explained in page 190, recommend their being combined to aid the effect of the stump. Such a style presents the advantages of both instruments of shading, namely, the rapidity and greater truth of the shade as produced by the stump, and the useful exercise in the drawing of lines, as well as the greater precision attainable by learners by means of hatchings.

Of Drawing the Outline.

The outline is to be drawn in the first instance lightly with prepared charcoal, of which all trace can, when required, be removed by rubbing the paper with chamois leather or any soft substance. Trusting to this power of effacing the charcoal outline, some learners are inclined to draw it too hastily, not bestowing sufficient care in producing neat and precise lines: the teacher should guard against the habit, and request the pupils always to have the charcoal properly pointed.

When a correct outline has been drawn with this material, and examined by the teacher, it is to partly effaced, so as to leave faint marks just distinct enough to guide the eye and hand in redrawing the same outline with precision in crayon. This forms the next step: the crayon used is No. 1. It is to be firmly grasped in the holder and cut to a

fine point. Crayons are cut or pointed in a manner different from that followed for lead pencils, the crayon being held with its point resting on the first finger of the left hand, and cut backwards from the point towards the hand.

Errors made in the crayon outline are effaced with the crumb of stale bread pressed between the fingers into a convenient shape. If the paper should, by the too frequent use of the bread, become greasy, so that the crayon cannot be made to mark, the greasiness may be removed by using Indian rubber, care being taken not to let the Indian rubber touch any part of the crayon intended to be retained Warming the paper at the fire will also remove this defect to some extent. The use of bread, however, always unfits in a greater or less degree the surface of the paper for the reception of shade; the pupil must not therefore acquire a habit of trusting to this as a means of correcting errors; and the use of the prepared charcoal in first tracing the outline should make it rarely necessary to have recourse to subsequent corrections when it is drawn in with the crayon.

Mode of Shading with the Stump.

The soft crayon, No. 3, having been rubbed down in sufficient quantity, (on the inside of the lid of the crayon-box, or on a piece of paper,) one end of the stump is rolled over the powdered crayon so that it may be charged equally all round. Before applying the stump to the drawing, it is to be rubbed on a piece of paper kept for the purpose, in order that the chalk may be distributed evenly over its surface, and also that the quantity with which it has been charged may be known. For dark shades, the stump is to be fully charged with chalk; for light shades it is to be slightly charged.

In applying the stump to the drawing the touch should be free and very light, avoiding always to rub the chalk hard into the paper*. Great care must be taken not to allow the shade to pass over the lines bounding the surface to be shaded; the point of the stump is therefore to be used when the shade is to be laid on at the edges; but for the interior shading of any surface which is not less than about half an inch in width, it is always preferable to apply the shade with the side of the stump, because greater evenness and uniformity are thereby attained,

* It is the more necessary to attend to this direction, that the paper likely to be used in schools would not be of such quality that its surface could resist much pressure or attrition, without becoming rough or woolly. This would not be the case with drawing-paper of a superior quality.

and it admits of greater rapidity of execution. When a certain space has thus been shaded, the other end of the stump, which should always be kept free from chalk, is then passed lightly over the surface in order to make it smooth and uniform. If the shade still present after this last process a spotty appearance, the parts that are too light must be retouched with the dark end of the stump, until all the surface is brought to the required degree of evenness. It is to be observed that with very little practice, if habitual care has been bestowed in applying the first shade slowly and lightly, little additional labour will be required to produce a uniform and pleasing effect.

Beginners inclined to shade too hastily.

Beginners, however, are inclined to shade too hastily, and to attribute the consequent defects to the inherent difficulty of the process; to corect this opinion, they must be induced to bestow time in the high finish of a small portion of the drawing, were it only one square inch of its surface, in order that they may become convinced that the producing of a smooth shade is really a mechanical operation presenting but little difficulty, and that can be performed by all if sufficient time be employed, the time varying of course according to the aptitude of each pupil. The members of the class should be made to understand that quality and not quantity is the element to be considered in appreciating their

power of drawing; the teacher will therefore avoid passing too hastily from one model to the next in succession, as the time bestowed in the earlier stages in producing the evenness and uniformity sought will be beneficially employed. He will point out that unevenness or spottiness in a shade is the result of some parts being lighter than the adjoining surface. All those whose eye enables them to detect this difference in the depth of shade will likewise be able, with care, to bring those lighter parts to a depth of tint corresponding to that of the surrounding surface by retouching them with the stump charged with a suitable quantity of chalk. But, as was said before, if the first shade is originally laid on with a light hand and with care, there will be little need for any subsequent retouching.

Uses of the Leather and Paper Stumps.

The leather stump is suited to produce deep masses of shade, as well as the most delicate tints. When deep shades are required they should be laid on if possible at once, because, by passing the stump a second time over the surface for the purpose of increasing the depth of shade, the contrary effect is often produced of making it somewhat lighter. It is by means of this property of the leather stump of taking up, or reducing shades, that errors committed in making parts too dark are corrected, and also that reflected lights are thrown in. If, therefore, it be desired to darken a tint which has already a considerable depth, the addition

is to be made by means of the paper stump. It is to be observed, however, that shades produced with the paper stump have a certain degree of harshness, which renders them less pleasing than those produced with the leather stump. The paper stump is especially used for applying the white chalk: it is also well adapted to the blending and harmonizing of the shades or shadows of rounded forms so as to avoid too violent a contrast at any one point.

The very light shades which are intended to blend with the neutral tint of the paper, or to serve as a link for a gradual passage from light to dark, are produced by the leather stump commonly used, but in such a case free from any additional supply of chalk.

The lights are produced by means of the paper stump, the white chalk being taken up with the stump, and laid on in the same manner as the black. In general it will be found that the stump (passed over the surface two or three times if required,) will produce lights sufficiently bright for the desired effect. When, however, a very brilliant light is to be produced, the white chalk is to be applied directly to the drawing, for which purpose it must be brought to a fine point, capable of producing clear and regular hatchings. It will prevent disappointment if the pupils are informed that it is more difficult to produce good hatchings with the white than with the black chalk, owing to the greater softness of the former.

Hatchings.

The broad and general effect of the drawing is to be produced solely by means of the stumps as above described; such an effect in fact as would give to the drawing the appearance of being finished, if viewed from a distance of about three feet. However, in order to give greater decision, brilliancy, and character; as also to produce a higher finish in the drawing, whereby it may be rendered more pleasing for close inspection; but especially for the most important end of training the hand to precision, hatchings are to be next applied. Hatching is a term employed to signify parallel, straight or curved lines, used for producing shades either in drawings or engravings. If skilfully disposed they are pleasing to the eye as mere shades; but their great use is the power they afford of making everything appear, without the aid of colour, of its individual nature and quality. Any one, in examining a well executed line engraving, will find that the effect of different substances is represented, and that he is enabled to distinguish flesh, wood, stone, water, metals, stuffs or any other material, by the particular expression produced by variously disposed plain or cross hatchings. This power is not required, however, for the course of drawing set forth in this Manual, the models which are to be copied being all made of wood, covered with a coat of white paint, presenting therefore a uniform and regular texture. Nevertheless, if hatchings be applied as we recom-

mend, each drawing, independently of its presenting greater precision, brilliancy, and finish, will thereby have served as a special means, of exercising the hand by the delineation of a great number of regular, straight, or curved lines. The pupil will thus, with every new model, be induced almost unconsciously, but certainly with interest, to repeat time after time an exercise of great importance, because it is only by an infinite number of trials that the skill can be acquired, which combines freedom and steadiness in the drawing of straight or curved lines.

Strength and General Direction of Hatchings.

With hatching no universal rule can be given as to the proper direction and amount of strength of the lines. Generally, it will be preferable to draw them in directions parallel either to the sides of the surface shaded, or coinciding with the direction of the plane in which that surface is situated. The hatchings, for example, would be made vertical on the representation of vertical surfaces; horizontal on the representation of horizontal surfaces; and inclined on the representation of inclined surfaces. When a curved surface is to be represented, the hatchings should be curvilinear, partaking of the general curve of the form to be delineated. In such cases two or more sets of hatchings may be made to cross each other with a pleasing effect. When hatchings are thus crossed, they should not meet at right angles, but always more or less obliquely, so that the intersections of two sets of hatchings would

produce diamond or lozenge-shaped openings. The pupils should be cautioned against making the hatchings too dark. Their strength should be proportioned to the depth of shade beneath, and they should be so drawn as to be undistinguishable when the drawing is viewed from a distance of about two or three feet. The crayons should be cut to a very fine point for the purpose; crayon, No. 1, being used for all light shades, and crayon, No. 2, for the dark shades only.

Drawings to be generally shaded from top to bottom.

When it can conveniently be done, it is desirable to shade the drawing from top to bottom, in order to avoid rubbing or defacing any of the work previously done; but this cannot always be adhered to, as it is difficult to judge of the effect of isolated parts of surfaces until the mass of shade belonging to an entire surface is laid on. Another reason, which also causes a departure from the process of shading regularly from top to bottom, is, that the darkest shade should in general be produced first, the others being laid on in succession according to the diminution of their intensity. By this means a better gradation can be preserved by learners, and too heavy shades are avoided. If, on the contrary, the drawing is commenced with the lightest shade, it is more difficult to make it of such a tone, that by a gradual increase in the depth the last or deepest shadow shall not be much too dark.

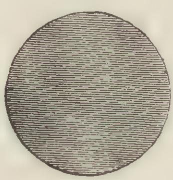
CHAPTER XIII.

OF LIGHT AND SHADE.

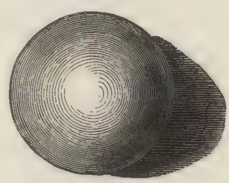
Outline alone insufficient for the Representation of Objects.

OUTLINE alone is not sufficient to complete the representation of an object in high relief, or to give an idea of relative distances, so that everything may appear in its proper place: various dispositions of light and shade are required to give the appearance of solidity and to vary the form of the object*. For example, the same circular outline may,

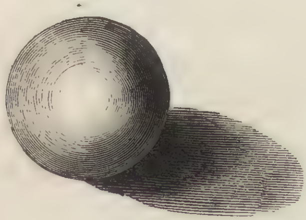
Circle



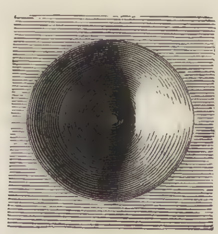
Circular disc.



Hemisphere.



Sphere.



Hollow hemisphere.

* By the word "outline" we mean simply lines of unvarying thickness in all their parts. If, in an outline drawing, the lines

according to the various adaptations of light and shade, be made to represent a circular ring, a flat circular disc, a hemisphere, a sphere, or a hollow hemisphere or cup.

Certain effects of Light and Shade observable in Nature.

In that branch of the science of drawing which refers to the disposition of light and shade, rules as precise and universal as those explained for linear perspective, cannot be pointed out as guides in every case. Nevertheless, as certain general effects of light and shade may be observed to obtain generally in nature, they will serve as guides or rules to be rarely departed from, although not capable of being applied with that universality and precision which characterize optical effects in as far as they influence the apparent magnitude of objects or directions of lines.

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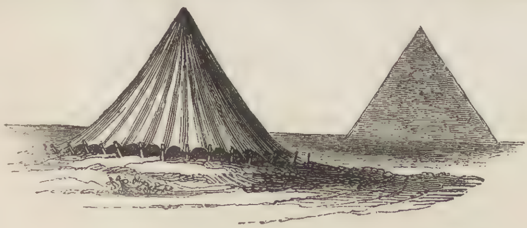
be varied, those on the nearer objects being made bolder and heavier than those more distant, and different parts of a line or lines swelled out and diminished to represent swelling or rounding forms, such outline drawing is then well adapted to give relief, and to produce the appearance of distance. Reitsch's well-known outline sketches attest the extraordinary power of effect rendered by such simple means when employed by a skilful hand; but, in such cases, the drawings cannot strictly be said to be in outline, the varieties in its depth and thickness constituting a kind of shadowing.

Aerial Perspective.

In contemplating an extensive prospect, all may have noticed that, on the objects and forms nearest to the eye, the most brilliant lights and the deepest shadows are seen; that these lights and shadows gradually diminish in intensity as the distance from the eye is increased; and, that in the most remote parts of the prospect, the lights and shadows cease to be distinguishable from each other, but appear to blend in a common gray or blueish tint. This effect, which is sometimes called aërial perspective, is observed in a greater or less degree in all cases; the following rule may therefore be founded thereon, namely, that, *in the representation of lights and shades in the drawing, the lights shall be made less brilliant, and the shades less intense, as the surfaccs on which they appear recede from the eye.*

By a careful application of this rule, the appearance of solidity or roundness, and of relative distances, will be easily given to the representation of objects previously drawn in correct lineal perspective upon a flat surface. Its importance is made manifest by the annexed illustration, which shows that "two angles may occupy the same space on the retina, but by this power one is made to approach and



the other to recede, so that one is diminished to the size of a tent, the other increased to a pyramid;" "also a row of columns will diminish according as they are drawn true to lineal perspective, but it is to this quality of light and shade that they are indebted for their effect on the eye*."

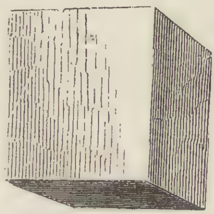
By again referring to the observation of an extensive prospect, a rule may likewise be established to guide in the drawing in of the outline. Not only is it found that the lights and shades diminish in intensity as they recede from the eye; but, as a necessary consequence, the contrasts between surfaces become also less prominent, and their outlines less distinct, the more the distance is increased. From this observed effect is deduced the following rule: that *in the drawing of the outline on the paper the lines shall be made fainter and finer the farther they recede from the eye.* A proper harmony will

* The apt illustration given in the text to exemplify the effects of aërial perspective is adopted from BURNET'S *Treatise on the Education of the Eye*, an excellent work, to which we have already had occasion to refer.

thereby be preserved between the shade of each surface, and the outline which marks its boundary.

No Line visible independently of the adjoining Surfaces.

This reflection leads to the consideration of an important effect in shaded drawings, which is, that no line is to appear in the finished drawing as a line singly, independent of the tints or shades on the adjoining surfaces. In nature, outlines are in reality but the boundaries of surfaces, and do not exist independently of those surfaces. If we examine an object, the cube, for instance, we see the lines which apparently separate one face from the other, only because the different faces of the cube present to the eye different shades or tints. There, where the exact boundary of any one tint terminates, a line seems to mark that boundary, but it does not exist independently of the surface of which it forms the limit: it merely constitutes a part of, or a continuation of, that shade or tint which belongs to the whole surface. The teacher will illustrate this proposition by laying on the desk, or fixing on the black board, a sheet of the tinted drawing-paper. The rectangular outline of the sheet of paper is made manifest by the contrast between the colour or shade of the paper, and the colour or shade of the desk or board on which it may be placed; nevertheless, the outline does not



exist independently of the remainder of the surface which it terminates; for, within the outline, the paper is of the same tint or shade as at the extreme edge, which differs in no way from the interior parts, and is only made manifest from its contiguity to another contrasting tint or shade. In order, therefore, to produce on a drawing as close an imitation as possible of the appearance of actual forms, no line should appear singly and independently as a mere line; but wherever it is desired to mark the boundary between two surfaces, that boundary must be indicated as on the model or in nature, by bringing the tint or shade of one surface to meet, at a very precise common boundary, the different tint or shade of the adjoining surface: the outline or separation between the two surfaces is thus made apparent simply by that *difference* in their tints. This required effect is always to be borne in mind when drawing the outline, which should be made sharp and precise, but never so dark as to prevent its being blended with or lost sight of in the shading, which is to be afterwards applied. And, inasmuch as the distant shades are to be made fainter than the near shades, the distant outlines are also to be themselves made fainter in the same proportion, otherwise they could not be properly subdued as required.

We have taken an opportunity of explaining this at length, because it is a very prevailing fault with learners to mark the outline too strongly. They should therefore be convinced by the above,

or similar explanations, that such a course is faulty. However, this being accomplished, some are liable to fall into the opposite error of leaving the boundaries of the surfaces indistinct, cloudy, and undefined, imagining that, because their outline is not to appear as consisting of mere lines, it is therefore to be indistinct and ill defined. The pupils should likewise be cautioned against this error.

Chapter XIV.

SHADES AND SHADOWS.

We have, in the preceding explanations, made use of the words *shades* and *shadows;* we now proceed to point out a distinction in their meaning.

Distinction between Shade and Shadow.

Mere shades or shadows are invisible. When we say, therefore, that we see a shade or shadow, we mean that we see the confines of light, or that we see bodies placed in shade or shadow partly illuminated by light reflected from collateral bodies. No opaque body or object can be lighted without producing two kinds of shade, the one being the deprivation of direct light suffered by that part of the body which is removed from the light, the other being the deprivation of direct light suffered by another body or object from which the first intercepts the light. The first we shall call *shade,* the second *shadow,* and the reason for making this distinction in the words is, that a distinction in the intensity of these two kinds of shade is almost universally found in nature.

Shadows darker than adjoining Shades.

The shadow is almost always darker than the shade on the adjoining surface of the body by which the shadow is cast. The reason of this is, that all shades receive a greater or less amount of reflected light from surrounding objects; in the case of that which we have described as a shaded surface, it is usually more nearly opposite to, and nearer other surfaces which themselves are in light, and from which it therefore receives a greater quantity of reflected light than that part of the adjoining body in shadow, which is usually placed more obliquely to the surfaces in light, and from which it receives therefore a less quantity of reflected light.

Of Reflected Light.

Rays of light falling upon a polished surface are, in a large proportion, reflected or thrown off from that surface at an angle or inclination similar to that at which they met the surface. This effect may be likened to the rebounding of a ball from an even surface on which it is thrown. If the ball strike the surface obliquely, it rebounds from it at an angle, or inclination, similar to that at which it struck; if it fall in a direction perpendicular to the surface, it rebounds back towards the point from whence it proceeded. A similar effect is observed, with greater or less regularity, with regard to the rays of light, according as the surface is more or less polished; and the reflection is more or less intense according as the

reflecting surface is of a lighter or darker colour. Any surface, therefore, which is towards a luminous body becomes illumined itself, and in an inferior degree illumines other objects in its vicinity. The teacher may illustrate this proposition by holding a sheet of white paper towards the light in such a position that it shall reflect the light on the under or shaded side of the cube, which will become illumined when the sheet of paper is so held, and become very sensibly darker when it is removed. Although all surfaces that receive light do not reflect back an equal quantity, yet all do so to some extent; and to a greater or less degree according as they are placed less or more obliquely with respect to the luminous body, and to other surrounding objects. Were it not for reflected light, those objects or surfaces which are not directly illumined would be so totally immersed in shade, as not to be visible: their exterior figure or outline only would be apparent.

A few examples will be sufficient to illustrate the kind of effect here alluded to: in nature it presents itself in endless varieties.

If an object bounded by flat surfaces be relieved from a wall, or other surface, and the light, as in the following diagram, be supposed to proceed from the left, we may notice three prominent varieties of tint. The lightest will be on those surfaces most nearly opposed to, or facing the light; the second will be on the side of the object from which the direct rays of the light are interrupted by the substance of the object itself, the third will be the

shadow cast by that object on a part of the surface facing the light, but which part is deprived of the direct rays of light by the interposition of the object in relief. Now the shade on the side of the projecting object appears lighter than the shadow adjoining, because, from the adjacent surface of the wall, a certain portion of light is reflected; and the sha ow is the darkest, because there is no surface far from which any strong light can be reflected to the place it covers.

Shadows appear darker when cast on a surface

in bright light, than when cast on a surface in fainter light or in shade; and the contrast in the first case between the shade and the adjoining shadow is greater than in the latter case. For example, in the annexed figure, in which the upper sides of the steps receive a smaller quantity of light than their upright faces, the shadows appear fainter on the upper than on the upright surfaces; and the contrast is greater between the adjoining shade and the darker shadow, than between the adjoining shade and the fainter shadow.

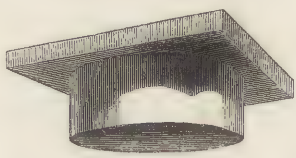
Also, in the case of a shadow falling, as in the preceding illustrations, on a flat surface, that part of the shadow which is nearest to the object which causes it is darker than the parts more distant; these shadows become gradually less intense the further they recede from the object whereby they are produced.

Character of Shadows in the broad Light of Day.

When objects are viewed in the broad light of day, but not directly exposed to the sun's rays, the shadows which they throw are vaguely defined, and do not follow the forms of the objects themselves. The lower parts only of the objects make that neighbouring part of the surface on which they stand, and which is on the opposite side from the light, a little darker than the rest: this is the most usual condition under which drawings have to be made, and the shadows in such a case present little difficulty.

Character of Shadows under direct light.

When shadows are cast by the interception of the direct rays of the sun, or of the rays proceeding from an artificial light, their outline assumes a certain definite form, depending on the shape of the intercepting object and the form of the surface on which they fall. For example, as appears in the two preceding illustrations, the shadow cast by a surface bounded by a straight line upon another flat surface will be a straight line, whereas, if it fall upon a curved surface it will assume a curved boundary,

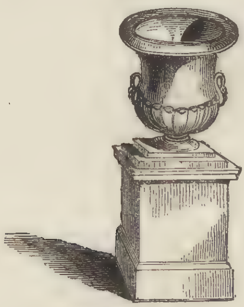


the exact character of which depends on the relative position of the two surfaces. The shadow cast by a straight edge upon a cylinder may be either circular or elliptical: the shadow cast by a straight edge upon a cone, may be either circular or elliptical, or presenting the form of the other conic sections: the shadow cast by a straight edge on a globe will always be circular. But as such effects, which are presented in numberless varieties, are further varied by perspective, according to the point of view from whence they may be seen, they would require directions much too minute and lengthened were it necessary to enter into their consideration. It is sufficient, however, to call the attention of the

student to a knowledge of those varieties, so that he may be prepared in each individual case to study and to represent the effect before him.

Shadows on Concave Surfaces.

In a niche, cup, or hollowed form, the shadow appears strongest at its edge or outline, and is



gradually softened towards that side of the object by which the shadow is caused, owing to the strong reflection from the other side, on which the light falls direct.

Reflected Light on Shaded Surfaces of Projectures.

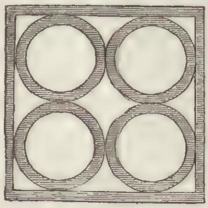
If light fall from above on an upright object resting on the ground or on any level surface, and

if that object have any projecting part, the under side of such projecture will of course be in shade. But it will not be so dark as the adjoining shade on the side of the object, because the reflected light which is thrown upwards from the level surface on which the object is resting, will be received by the projecting part, while a very small quantity of it can strike the sides of the object.

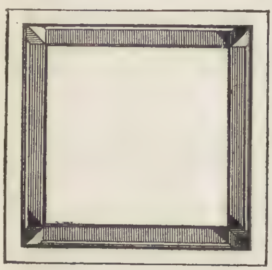
Selection of Advantageous Points of View for the delineation of the Models.

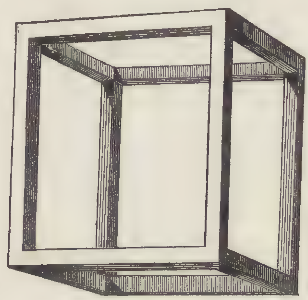
The teacher in presenting to the class the models in the order set forth in the Plates, will aim at selecting such a position for each model that it shall present as favourable a point of view as possible to the majority of the class. According to the disposition of the light, and the arrangements of the desks, there will in general be a certain part of the class-room from which the models would usually appear to the greatest advantage; for this reason the teacher will, when convenient, take opportunities of varying the positions of the pupils as suggested in Nos. 20 and 21, page 241.

As it is of importance that the judgment of the pupils should be cultivated with regard to the best points of view from which objects may be drawn, the teacher will occasionally point out the superiority of one position to another to give effect to the drawing; for example, the annexed figure



viewed in front, and placed on the same level with the eye, does not produce as pleasing a drawing as if viewed obliquely and from beneath; the drawing also of the hollow cube, viewed from a point square





opposite to one of the surfaces, is not so effective as the drawing of the same model if viewed obliquely and from beneath.

GEOMETRICAL PERSPECTIVE.

Chapter XV.

GEOMETRICAL PERSPECTIVE.

Preliminary Observations.

As this Appendix is not designed for a complete treatise on geometrical perspective, it is not intended to do more than to explain the fundamental theorem of all linear perspective, first demonstrated by Dr. Brook Taylor. When the theorem in question is once thoroughly understood, all problems connected with the perspective representation of objects, bounded by right lines, can be solved, if sufficient perseverance be brought to their analysis to consider them part by part. We, in fact, believe that it is actually preferable for those students who are unaccustomed to mathematical studies, that their attention should be directed to this single theorem, which, with a little patience, they will be enabled to understand; whereas, if their attention were at the same time, or immediately after, directed also to the various cases considered by Dr. Taylor (and those cases are very few, indeed, when compared with the number treated of in some voluminous works of later date), they would only become perplexed and discouraged in the study, because their assumed limited knowledge of the geometry of planes would prevent them from perceiving that the cases in question were only par-

ticular applications of the first general theorem, which, as, by degrees, it became better understood, would enable them, without reference to any other assistance, to solve particular cases in great variety.

It is true, that by thus for a time confining the attention of the inexperienced mathematician to this single theorem, more rapid modes of execution suited to various cases are not learned. The time which would be saved by those more direct operations would be a very inconsiderable gain if the operations themselves were only to be performed by the guidance of empirical rules; for such constantly lead to errors from the want of a clear understanding of them. The more rapid processes we refer to are useful only when they can be executed in all their varieties with a due intelligence of their guiding principles; but a geometrical knowledge very much superior to that assumed for the case we are considering would then be required.

The teacher will find that pupils who shall have passed through the course of drawing described in the first part of this Treatise, and thereby acquired a thorough knowledge of the perspective of feeling, will be competent to understand the investigations which follow, although they might not previously have possessed any mathematical knowledge. The habit of precision of thought inculcated, as also the frequent consideration of geometrical forms and figures, rendered necessary by the preceding exercises and investigations, while

offering an advantageous transition from the vague generalities that too often characterize what are denominated popular studies, will have formed a proper groundwork to prepare the pupils for the closer reasoning essential in mathematical investigations.

In order not to make this transition too abrupt, the teacher would of course continue to avail himself of all practicable ocular demonstrations; such, for instance, as those which we have indicated to facilitate the understanding of the definitions and axioms: and he will especially dwell at length on the consideration of that figure, (Plate A,) in which, by means of the threads intersecting the transparent plane of muslin, an exact idea is given of the object of geometrical perspective. We would recommend the teacher to prepare in such a case a figure similar to that given in the plate, but on a much larger scale, and made of strong card board, so as to admit of its being carried and placed in the hands of the pupils without disarrangement in the parts. Any pains which the teacher may bestow in initiating his pupils into this attractive mathematical study will be amply repaid by the beneficial results which they will not fail to derive from it. Independently of other considerations, such study strengthens the powers of the mind, and by training it to patient investigation and close reasoning, "gives that vigour which achieves excellence, and commands success in every department of life."

Geometrical Perspective.

Definition of Perspective.

The science of Perspective consists in delineating on a plane or flat surface the representation of objects, so as to convey to the eye the image of the objects themselves.

Illustrations of the object of Perspective.

The process to be followed will be indicated by the following explanation:—

Let a transparent plane (a pane of glass for example,) be imagined interposed between the object to be represented and the eye of the spectator; and let it be supposed that the rays of light which proceed from the visible parts of the object to the eye leave a mark at those points where they intersect or pass through the transparent plane; then, lines joining those imaginary points would evidently hide from view, or seem to coincide with, the corresponding lines on the object. They would, therefore, produce a correct perspective representation; for, the original lines of the object might be removed, and those traced on the transparent plane would continue to convey to the eye the image required.

The student may carry this supposition into

effect, if, looking through a pane of glass in a window, closing one eye and keeping his head unmoved, he trace on the glass with a fine hair pencil charged with gum water and whiting the outline of any object beyond the glass, as if the pencil touched the object itself: such outline would be a correct perspective representation of the object. As a change of position of the eye would necessarily alter the points at which the rays of light, passing from the object to the eye, would meet the glass, and therefore change the representation, it is essential, in order to perform this operation correctly, that the position of the eye be kept unaltered throughout. This may be accomplished by looking through a small hole in a thin plate of metal fixed at a convenient distance from the glass.

Were representations of objects to be always thus drawn on transparent planes, this simple operation, with the principle on which it is founded, would comprise the whole theory and practice of perspective. But it is manifest, that while such a process would at all times be inconvenient, and under many circumstances could not be resorted to, it could not produce the desired result on paper, canvass, or any of the opaque substances on which the representations are usually required to be drawn. Such an operation, moreover, being altogether independent of skill or effort of the mind, would offer no interest. The draughtsman, therefore, resorts to the science of perspective, by means of which he determines, independently of mechanical contrivances,

the positions of the imaginary points of intersection, without the actual interposition of the transparent plane.

Fundamental Problem of Perspective.

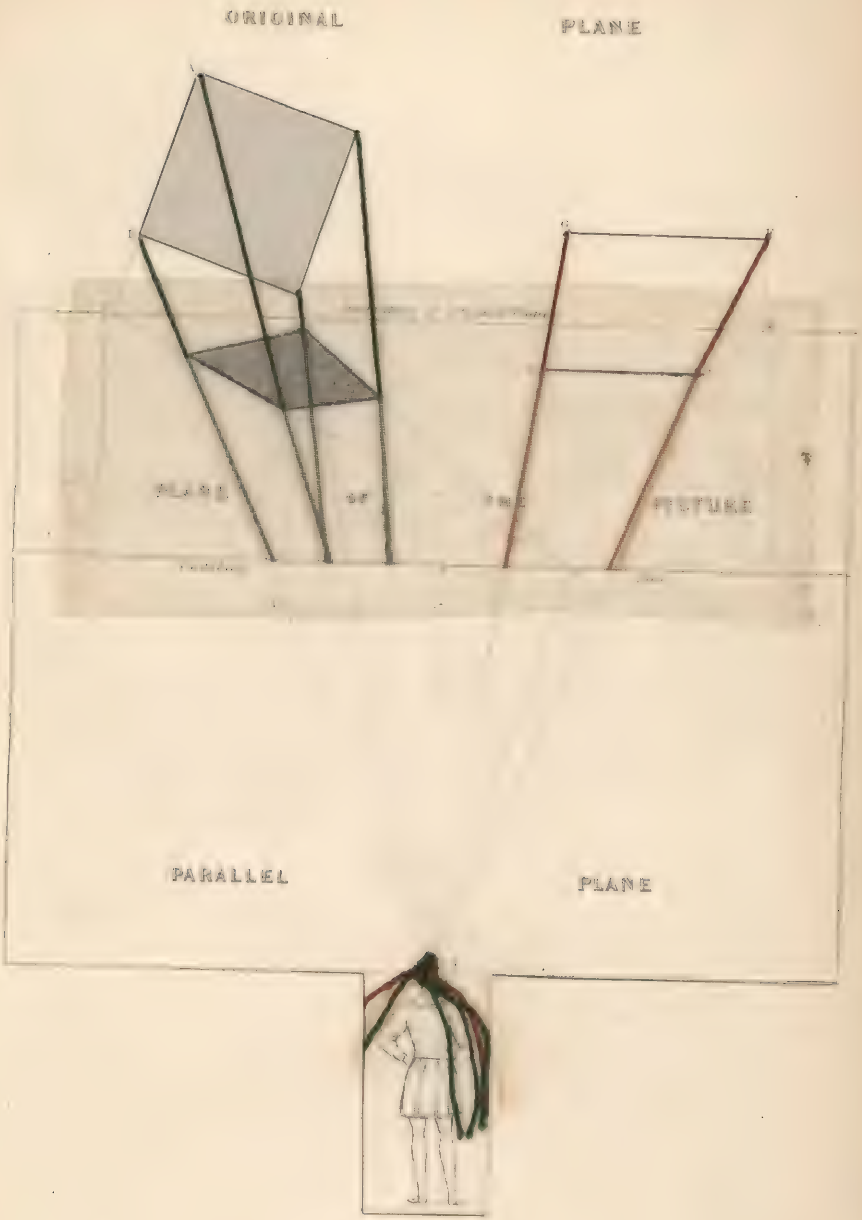
The fundamental problem of perspective resolves itself into the following, namely:—To determine the section of the interposed plane, or plane of the picture, with the rays which proceed from the object to the eye.

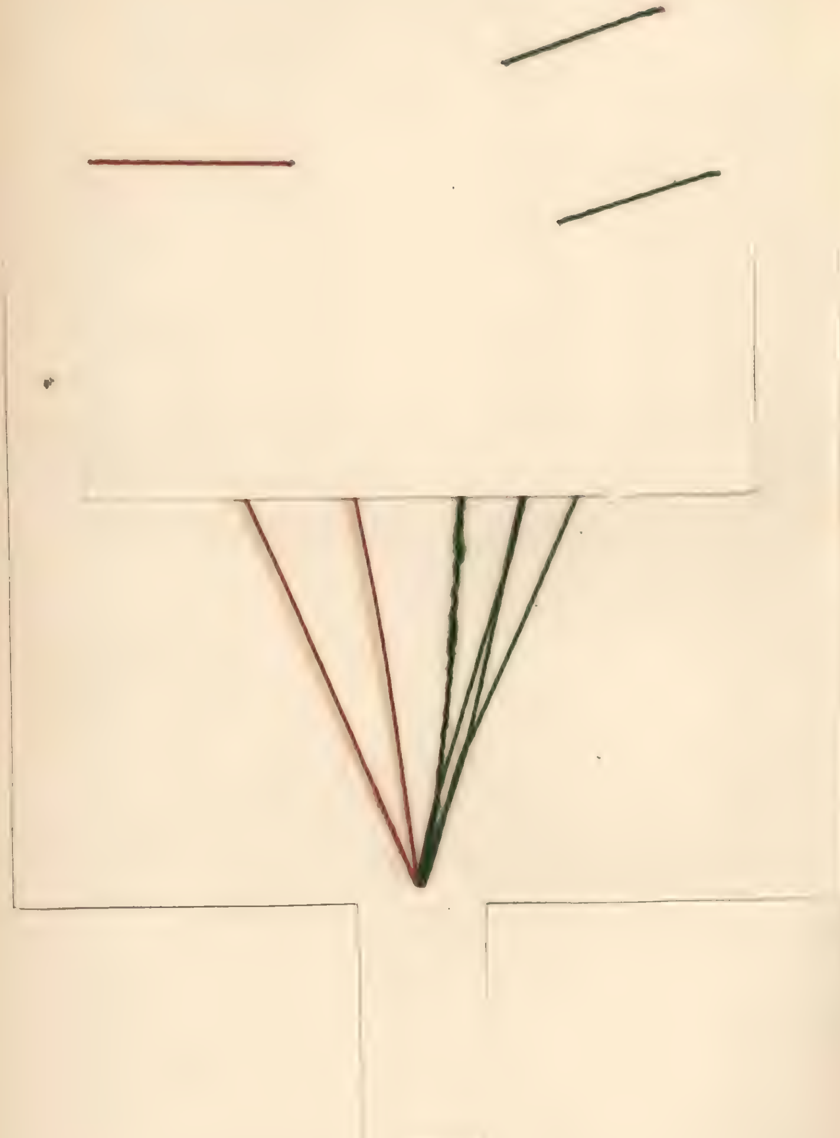
The student, to whom the above enunciation may, from a want of familiarity with the geometry of planes, appear obscure, will readily understand its meaning by means of the mechanical illustration afforded by Plate A.

Mechanical Solution of the Problem.

Let the moveable transparent surface be raised into an upright position, and the image of the spectator be bent until it stand also in an upright position, parallel therefore to the transparent plane; and let the threads be strained until they pass in straight lines from the corners of the square to the supposed eye of the spectator; then the threads, which represent the rays of light, mark by their intersections with the transparent plane the perspective of the square as it would appear if viewed from the point representing the eye of the spectator. Let the different parts of the plate be now laid flat: the square, the eye of the spectator, and

Pl. A





that part of the flat surface which represented the upright plane of the picture, are all fixed in position and in size with reference to each other. The science of perspective then consists in determining geometrically, with such data and on a surface which is not to be bent, the intersections which were, in the first position of the plate, made manifest by mechanical contrivance.

A few preliminary definitions will give greater conciseness to the investigation of the rules; and certain axioms must previously be agreed upon to aid in the complete solution of the problem.

Definitions.

I. A *plane* is a flat surface capable of being extended without limit in any direction.

II. The *plane of the picture* is the flat surface on which the representation is to be made: it is the substitute for the transparent plane referred to in the preceding illustrations.

III. The *original plane* is the surface on which an original line or figure to be represented is situated. In Plate A, the surface A B is the original plane.

IV. The *intersection of the original plane* is that line which marks the intersection of the original plane with the plane of the picture. In Plate A, the line C D is the intersection of the original plane.

V. The point where any original line, continued if need be, cuts the plane of the picture, is called the *intersection* of that line. In Plate A, the point C is the intersection of the original line.

VI. A plane passing through the eye parallel to the original plane is called simply the *parallel* of that original plane. In Plate A, when the surface D V was raised in the position first described, the height of the spectator being equal to the height of the plane of the picture, that surface D V was the parallel of the original plane.

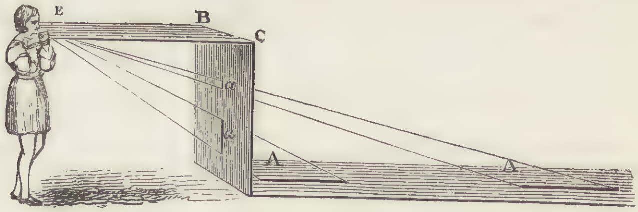
VII. The *vanishing line* of the original plane is that line which marks the intersection of the parallel plane with the plane of the picture. In Plate A, the line V V′ is the vanishing line of the original plane.

VIII. The *vanishing point* of an original line is that point where a line, drawn through the eye parallel to the original line, cuts the plane of the picture. In Plate A, the point V is the vanishing point of the original line A B.

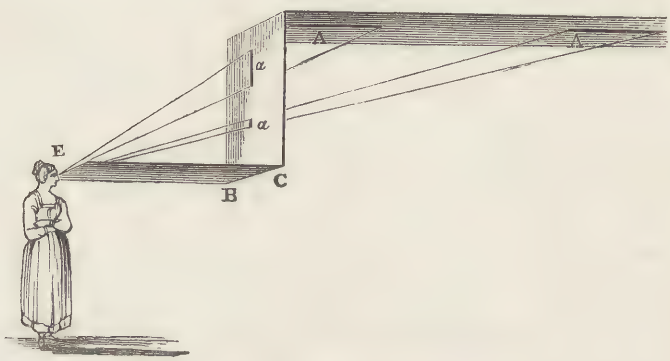
Use of, and Reasons for the adoption of the above Definitions.

The preceding definitions, with the exception of the two last, are only for the purpose of agreeing on the use of a single word or concise sentence, instead of a longer explanatory phrase. The words so defined do not contain any meaning not embraced in the longer explanation; their use is therefore evident. But this is not the case with the two last, in which the word *vanishing* is proposed to be used, without the accompanying explanatory phrases indicating the reason for its adoption. Subsequent explanations show the appropriateness of this term; yet, without anticipating on those explanations which require previous investigations, the following illustrations will in some measure account for the selection of the term *vanishing*.

Let A be an original line or figure, the perspective representation of which is *a*, and let E B C be the parallel plane passing through the eye at E. The farther the original object is removed from the picture the smaller does its perspective become, and the higher does it rise in the picture, until at last, if the object is supposed to be at an infinite distance, its image will vanish in an imagi-



nary point exactly as high above the bottom of the picture, or the intersection of the original plane, as the eye is above the original plane; it will vanish therefore in the line B C. If the original object, instead of being placed below the original plane, were placed above it, a similar effect would still take place; the farther it is removed from the picture the smaller does its image become and the



lower does it fall in the picture, until at last, if the object is supposed to be at an infinite distance, its image will vanish in an imaginary point exactly as much below the top of the picture, or the intersection of the original plane, as the eye is below the original plane: it will vanish therefore in B C.

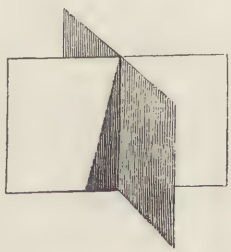
Hence the name given of *vanishing line* to the line marked by the intersection of the parallel plane with the plane of the picture. For a similar reason the name of *vanishing point* is given to the intersection with the plane of the picture, of a line drawn through the eye parallel to the original line.

Axioms.

I. A straight line may be applied or laid evenly on a plane in any direction. For example, the straight wire may be laid evenly in any direction on the wall of the room, or on any flat surface.

II. One part of a straight line cannot be in a plane without the remainder of the line or the line produced being also in the same plane. For example, if any part of the straight wire be applied to the wall, or to any flat surface, it will throughout its whole length touch or lay evenly on such surface.

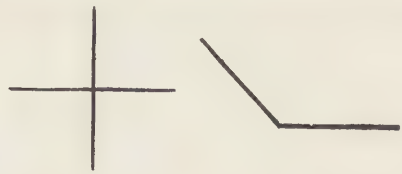
III. If two planes cut one another, their common intersection is a straight line. For example, the intersection of any two of the sides of the room is a straight line. Also, in Plate A, when the transparent plane was upright, its intersection CD with the original plane, or V V′ with the parallel plane, formed a straight line.



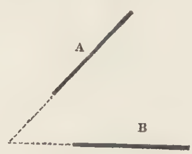
IV. If two straight lines meet or intersect in a point, they are both in the same plane; and if two straight lines, not parallel to each other, are situated in the

same plane, they must, if produced, meet or intersect in a point.

For example, any of the wire models composed of two straight lines, may be applied or laid evenly



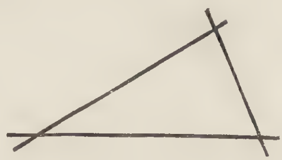
on the wall of the room, or any other flat surface; and any two lines A and B, not parallel to each other, and drawn on the paper or slate, must, if produced sufficiently far, meet in a point.



V. If two straight lines be parallel to one another, they are both in the same plane. For example, the parallel sides of the slate, or two parallel lines in any of the wire models, may be laid evenly on any flat surface.

VI. If two straight lines, being parallel, are both cut by a third, they will all three be in the same plane. For example, any three sides of the wire model of the parallelogram or the square, may be applied evenly to any flat surface.

VII. If three straight lines meet or cut one another not in the same point, they will all three be in the same plane. For example, the three sides of any of the rectilineal wire triangles may be applied evenly to the wall of the room, or any flat surface.



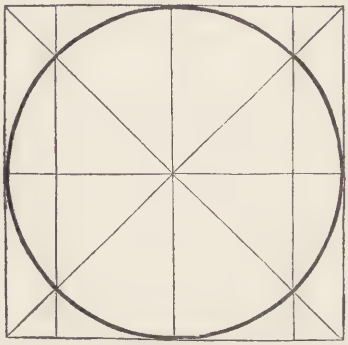
Perspective of Objects referred to the Perspective of a Single Line.

In order to obtain the perspective representation of any object bounded by straight lines and plane surfaces, each one of the lines which form the boundary of the object, or of its surfaces, may be considered singly and in succession: their perspective representations being afterwards combined, a correct view of the whole will be obtained.

All, therefore, that is requisite in such a case is to investigate the means whereby a single line in any position may be placed in perspective, which problem may be thus enunciated, namely:—To obtain the intersection of any line with the plane of the picture; the relative positions and magnitudes of the line, and of the plane of the picture, as also the position of the eye being given.

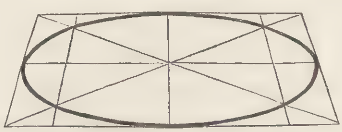
As regards objects bounded by curved surfaces, for example, a circle, a ring, a globe, a vase, &c., in which no particular points or lines can be selected

to determine the form; their true, or geometrical, curved outline or contour must first be traced. Such curve or contour is then supposed to be enclosed within, or terminated by, imaginary straight lines,



Circumscribing lines to aid in placing the circle in perspective.

which are placed in perspective according to the process to be described, for a single straight line. The points in which these straight lines touch or intersect the curve are thereby determined; and as



Circle drawn in perspective by means of certain points in circumscribing lines.

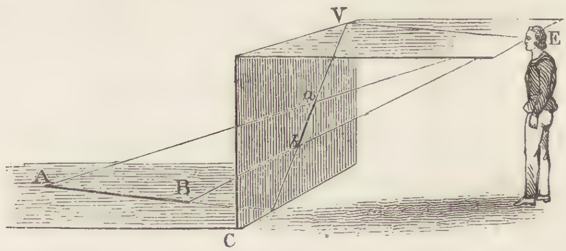
they may be made as numerous as it is thought desirable, a curve traced through them will give the required perspective of the original figure.

Solution of Fundamental Problem.

We now proceed with the investigation of the solution of the problem as regards the straight line, to which all other cases may be referred.

Let the moveable parts of Plate A, be brought into the position described in page 218, that is, with the plane of the picture vertical, and the parallel plane parallel to the original plane: the rays of light passing from the extremities of the straight line A B to the eye at E, form with the straight line a triangle. In that triangle the perspective of the original line will evidently be placed. But as the perspective of the line must also be necessarily in the plane of the picture, these two conditions can obtain only at the line which marks the common intersection of the two planes, that line being the only one which is situated in both planes.

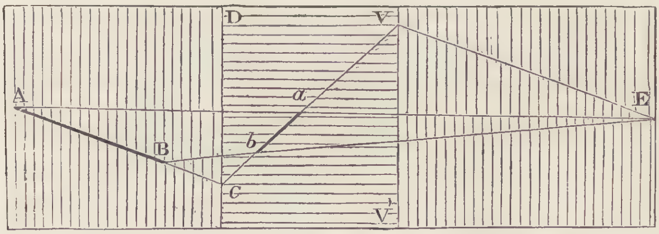
The moveable plate being retained with all its parts in the same relative position, let the student hold the book in such a position with reference to his eye that the upper thread passing from A to E shall hide from view the lower thread passing from B to E; the eye will then be in the plane of the triangle A B E. This position being kept steadily, the lines E V and V C will appear in the same straight line with A B and with the threads; in other words, the lines E V and V C are also in the plane of the triangle A B E; that is, the line E V, which is parallel to A B, and the line V C, which joins the intersection C of



the line A B, with the vanishing point V of its parallel E V, are in the same plane. But that part of V C which is intersected by the threads or rays of light at *a* and *b*, is the perspective of A B; the perspective *a b* will therefore be determined by first drawing the rays of light A E, B E, and marking their intersection with the line V C, which is itself obtained by drawing through E the parallel of the original line A B, and joining the intersections of the parallel and the original lines with the picture.

The above is the ocular demonstration of the theorem, which is investigated geometrically, as follows:

Let the moveable parts of the plate be laid flat, but let the reader continue to bear in mind the



Original Plane. Plane of the Picture. Parallel Plane.

distinction between the three surfaces respectively separated by the lines V V′ and C D: E represents the position of the eye, A B the original line, V V′ D C the plane of the picture, A B C D the original plane and E V V′ the parallel plane.

Draw the straight lines A E, B E, representing the rays of light; produce A B to C, its intersection with the plane of the picture; through E draw E V parallel to A B, intersecting the plane of the picture in V; join V C; then *a b*, the part of V C, which is cut off by the rays A E, B E, is the perspective required.

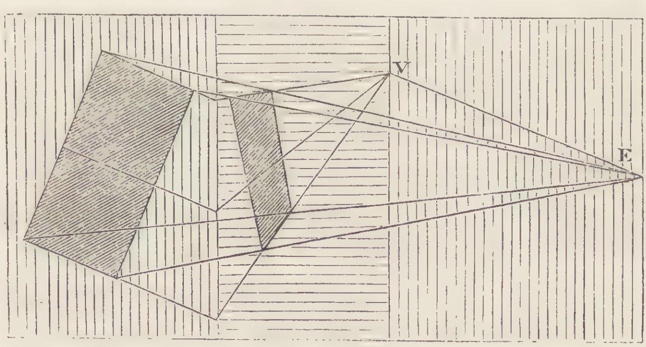
For, first the perspective must necessarily be in the triangle A B E; in other words, the perspective must be at some certain points in the rays of light. Secondly, the line A B C meeting the picture in C, is (Axiom II.) in the plane of the triangle A B E; and the points *a*, *b*, C, being in the intersection of that plane with the plane of the picture, are in the same straight line (Axiom III.). Also the line E V, intersecting the picture in V, being parallel to A B, and both being cut by the line A E, the three lines A E, E V, and A B, are (Axiom VI.) in the same plane; for the same reason the three lines B E, E V, and A B, are in the same plane, and consequently the lines E V, V C, and A C, are in the plane of the triangle A B E. But V C is the intersection of the plane of the triangle A B E with the plane of the picture, the line *a b* is therefore the perspective of the original line A B, being situated in the plane of the picture and also in the plane of the triangle A B E.

This result will be expressed in general terms as follows:

The positions of the eye, the plane of the picture, and the original line being given; first draw the rays of light from the extremities of the line to the eye, produce the original line to its intersection with the plane of the picture, through the point denoting the eye draw a line parallel to the original line, and produce it until it shall intersect the plane of the picture in the vanishing line, join the two points of intersection thus obtained, the part of this latter line included within the rays of light is the perspective required.

The Perspective Representations of Parallel Lines converge towards the same Point.

Hence it follows that the perspective representations of all lines that are parallel to one another converge to the same point in the vanishing line, for there can be but one parallel drawn through the eye, common to them all, and consequently but one



Original Plane. Plane of the Picture. Parallel Plane.

point of intersection, towards which they all converge. It is called the vanishing point of those lines, because if they were removed an infinite distance from the picture, at that point they would vanish.

The Perspective Representations of Lines parallel to each other and to the Picture, tend towards a point at an infinite *distance; they are therefore parallel to the originals.*

But how shall the perspective of any original line or lines parallel to the picture be obtained? for it is evident that a line drawn through the eye parallel to the original line could not intersect the picture. Here the theorem still holds good, only that the vanishing point of such parallels is then supposed to be removed to an infinite distance; in other words, they have no vanishing point towards which they converge, and their perspective is parallel to their original direction.

This is proved strictly as follows:

The perspective, fg, of any line F G (see also

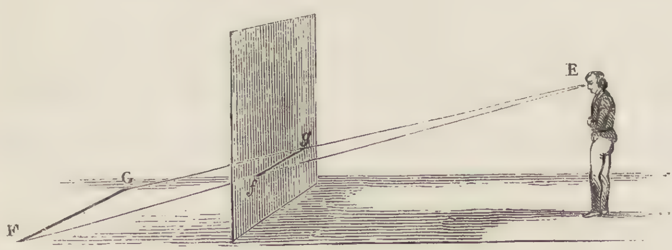


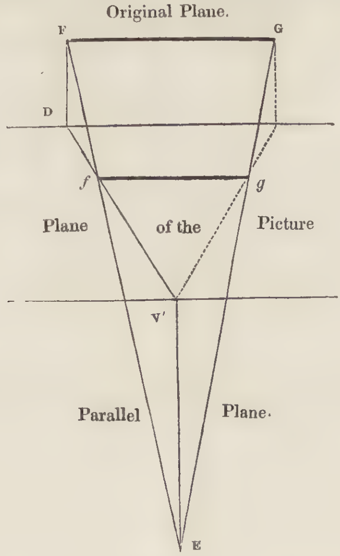
Plate A,) parallel to the picture, is parallel to the original line. For by the definition of the object of

perspective, *fg* is the intersection of the plane of the picture with the plane of the triangle F G E; *fg* is therefore in the plane of the picture. It is also parallel to F G, for if it were not it would meet it if produced, and the plane of the picture in which it is situated would therefore, if produced, meet the line F G, which is contrary to the hypothesis that F G is parallel to the plane of the picture.

Hence is drawn the conclusion, that *the perspective representations of all lines parallel to the picture are parallel to the original lines.*

Perspective Representations of Lines parallel to the Picture; how obtained.

The application of this last theorem is not, however, sufficient in itself to give the perspective of an original line parallel to the picture; because the points of intersection C and V, used in the first problem, cannot in such a case be obtained. It is only necessary in that circumstance to draw (see following diagram, and also Plate A,) a line F D in any direction not parallel to the picture, producing it to the intersection D; the line F D is then placed in perspective by the general theorem, and consequently the point F, one extremity of the line F G, is thereby also placed in perspective. A similar operation would also determine the perspective of G; but this last is unnecessary, because, applying the theorem which proves that the perspective of a line parallel to



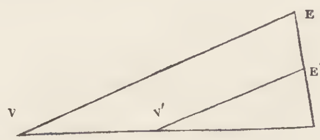
the picture, is parallel to the original line, it will be sufficient to draw through f a line parallel to F G, continuing it until it meets the ray G E in g; $f\,g$ is then the perspective of the original line F G.

Perspective Representations of Lines, how obtained, when the vanishing points are at inconvenient distances.

It will frequently occur that in practice the original lines, although not exactly parallel to the picture, may be very nearly so, in which case the lines produced, as also their parallels drawn through the eye, would meet the intersection of the picture and the vanishing line at such great distances as not to be embraced in the paper on which the lines are

to be drawn. In such a case, a simple way of obviating this inconvenience is to draw, (as for the case of parallel lines,) from the extremities of each original line, lines perpendicular, or nearly so, to the intersection of the picture, and by placing these auxiliary lines in perspective, to determine the perspective of the extremities of the original line without actually obtaining its vanishing points.

Another simple graphic method of obviating the inconvenience of vanishing points removed far from the place where the drawing is being made, is by



applying the property of similar triangles, which causes the sides about the equal angles to be proportional. But we think it unnecessary to explain its application, because this Appendix is not intended for a complete Treatise on Perspective; and also because the first method we have explained being capable of solving all the problems within the reach of the last, it is unnecessary to perplex the student with the consideration of more than is absolutely essential to the clear understanding of the theory, and the ready performance of the practice of perspective.

Closing Remarks on the more advanced Study of the Theory of Perspective.

The chief difficulty encountered in the study of geometrical perspective by the student unaccustomed to consider the intersection of planes, consists in his inability to realize or form a clear idea of the connexion between the original plane, the plane of the picture, and the parallel plane; as also the relation of the position of the eye and the original line to those planes, because he sees those planes which he knows to be more or less nearly perpendicular to each other, projected or drawn on a flat surface. The surest way to overcome this difficulty will be to refer frequently to Plate A, and placing its parts in the working position, described in page 218, to examine their relation to each other, so as to continue to have a clear idea of them when the whole is again laid flat. Let him then apply the principle to the perspective of a single line on a loose sheet of paper, which he may bend into a similar form, so as to place the space to be occupied by the picture, at right angles to the space to be occupied by the original and the parallel planes. Let him then write down those distinguishing words on the corresponding spaces on the paper; and, laying it flat, proceed with the operation. He will thus see clearly the reason for each step he adopts, and this knowledge not being merely the result of rote-work, will not readily be forgotten; while, simple and limited as it may seem, it will be applicable to all varieties of cases.

It may be an inducement to the student to persevere until he becomes master of the principle, if he reflect that the theory of Perspective is thus embraced in the consideration of a single problem. If he desire, after mastering it thoroughly, to pursue the study to its application in a variety of cases, we would recommend Dr. Brook Taylor's Treatise for a text book. But here we would add, not with the view to dissuade him from such further pursuit, but simply to return to our first position as regards the application of perspective knowledge to practice, that he will certainly find more advanced investigations useful in theory and improving to the mind, but that he must not expect to find them readily available to the perspective representation of the many familiar objects which he might wish to delineate, without their application involving an incommensurate amount of labour and expenditure of time. This sacrifice would be to him unnecessary after he should, by passing through the course of Drawing here set forth, have acquired a ready power of delineation, the necessary result of a knowledge of principles combined with the practical education of the eye.

Chapter XVI.

DIRECTIONS AND GENERAL ARRANGEMENTS FOR THE CONDUCTING OF THE DRAWING CLASSES.

It has been deemed expedient to insert in this Manual a series of minute and carefully digested Directions for the conducting and general arrangements of the drawing classes, a strict attention to which will greatly simplify the labours of the teacher when introducing drawing into a school in which it may not have been taught previously. They may, perhaps, seem too minute in the estimation of those inexperienced in the teaching of children; but the arrangements hereby suggested, or others of a similar tendency, are not to be neglected, as by their observance is maintained "that good order which cannot be inculcated too soon, nor insisted on too strongly."

1. There will be suspended in a conspicuous part of the class-room two sheets mounted on boards: one shall contain the rules of linear and aërial perspective, the second shall contain the definitions of the technical terms required to be known by the pupils.

2. The space required for each pupil is not less than 2 feet 2 inches wide.

3. A board, running beneath the desks, (which may be the same as those used for the writing class,) serves to support the feet, and to keep them in place.

4. Each pupil's place is furnished with a shelf beneath the desk, which serves as a depository for the drawing materials required during the lesson.

5. The following are the materials required for each pupil for the first and second parts of the course.

For the first part of the course:—

1st. A drawing-slate.

The drawing slates are all equal in size, 18 inches by 14 inches. To the middle of the upper side of the slate a small piece of sponge is fastened by a string long enough to reach to every part of the slate. Towards the left-hand corner of the frame a notch is cut, in which the end of the string next the sponge is held, when the latter is not in use.

2nd. A chalk-holder.

The chalk-holder, except for very young children, should not be less than six inches in length, and should be large enough to clasp the white chalk.

3rd. Prepared white chalk.

For the second part of the course, the following articles are required:—

1st. Two crayons (No. 1, and No. 2).

2nd. Two chamois leather stumps.

3rd. A paper stump.

4th. Soft crayon (No. 3), to be used with the stumps.

5th. A sheet of tinted drawing-paper.

6th. A sight-rule.

7th. A small piece of the crumb of stale bread.

6. Before the beginning of the lesson the sponges should be slightly damped, but the water pressed out of them.

7. The pieces of white chalk are to be pointed, and fixed in the holders.

8. After the lesson, the drawing-slates and sponges should be cleaned, and, with the other materials used, put in their proper places.

9. When drawing-paper is used, the name of the pupil and the date should be written in the upper left-hand corner of the sheet.

10. When the drawings on paper are completed they should be set apart by the master, for the purpose of being carefully inspected at a convenient time in the presence of the class, previous to their being put aside in the press.

11. A press is provided capable of holding:
- 1st. The two model stands.
- 2nd. The series of models.
- 3rd. The drawing-slates.
- 4th. The finished drawings.
- 5th. The blank drawing-paper.
- 6th. The boxes containing the chalk-holders and drawing materials.

12. The first series of models, consisting of the wires, should be divided into two sets:—

The first set, embracing the figures presenting a continuous outline, should be suspended from a peg fixed horizontally, with an upright projection at the end, and of sufficient length to admit of all the models being placed so as not to become entangled.

The second set, embracing the figures that do not present a continuous outline, should be laid on an inclined

board, with their bases kept in place by a moulding raised about 2 inches, encircling them at a convenient distance.

13. These two sets of models should be suspended from the peg, or placed on the inclined board, in the order of progression adopted for the lessons; and, consequently, so that the exterior or upper model shall be that one next wanted for the ensuing lesson. The models used during each lesson should be replaced, after the lesson, at the back of or below the remainder. They will thus be out of the way until the whole series has been gone through, when the same order will be followed with the next succeeding class.

14. The second series of models, consisting of the solid geometrical figures, should be placed on the lower shelves. Those which form parts of the elements of a compound object should be laid by in the compound form.

15. When the drawing-slates are laid aside, care should be taken that no sponges are left between any two slates, as the unequal pressure caused thereby might crack the slate or warp the frame.

16. The finished drawings should be laid flat on a shelf, in the order in which they have been drawn, the first drawn being placed underneath. To separate each set of drawings made from the same model, a narrow strip of white paper should be laid over the uppermost drawing, of a length sufficient to project both ways beyond the drawings. On the projecting parts of these slips of paper, the description of the figure and the number of drawings it covers may be written; and the slips should be so placed in steps that these references may be read with ease without disturbing the

order of the drawings, in the same manner in which the letters of the alphabet are disposed on the edge of a ledger.

17. In handling the blank paper and the drawings, care should be taken not to crumple the paper, nor allow the drawings to be rubbed.

18. When the class is numerous (comprising from forty to fifty pupils or upwards), it will be desirable that a dark cloth be suspended from the wall behind the models, in order that they may be clearly relieved from the back ground, and thus distinctly seen by every member of the class.

19. When circumstances will admit, it will be desirable to avoid cross lights falling on the models, that is, the light should not be allowed to fall on the models from both sides of the room. The most advantageous light for the appearance of the models would be, generally, a light proceeding from either side, and falling on the model at or about an angle of 45°; and, for the pupils, the most convenient light would be that proceeding from their left side.

Order of the Class.

20. So long as the class is occupied in drawing in outline on the slates, it will be desirable that at each lesson the pupils should occupy different positions, to avoid the habit of viewing the models constantly from the same point of view. To effect this change without confusion, each row of pupils should occupy in succession each desk in the class-room, commencing from the first, or that nearest the model.

21. When the pupils shall have commenced to draw on paper, this regular change in the position of each cannot be effected, for, when a drawing is not finished in one lesson,

the pupils and the model must occupy in the next the same relative position. The teacher, however, should not lose sight of the advantage of occasionally changing the positions of the pupils, and should take convenient opportunities for so doing, such as when a new model is to be drawn at the beginning of a lesson.

22. The class will consist of two sections, namely, monitors (see Nos. 44 and 51), and the ordinary pupils. The pupils, with the exception of the monitors, will, at the beginning of the lesson, take their places as ordered by the master.

23. The drawing-slates, or sheets of paper, will then be taken out and distributed by the monitors. Each pupil on receiving his slate, will place it, with the greatest dimension in a line with the lower edge of the desk. Neither the slate, nor the sheet of paper should be turned for the purpose of drawing any line with greater facility, for it is important that the hand should acquire freedom in the drawing of lines in any direction.

24. A monitor will be entrusted with the distribution of the chalk and the other drawing materials, which are to be all put down for each pupil to the right of the slate or paper.

25. No one is to commence drawing before the order to do so has been given by the master. The drawings from each model are to be made simultaneously by the whole class. As long as they consist in the outlines on the slate, they will generally be finished with equal rapidity; but, when drawing on paper, the teacher will find a difference in the time required by different pupils; before

passing to a new model he will wait until all, or nearly all, have finished the drawing in hand, and any spare or surplus time with those who have terminated their drawings first, will be usefully employed in giving a higher finish to their work. When a new model is presented, all should commence drawing from it at the same time.

Mode of using the Drawing Materials.

26. When drawing, the body is straight, leaning slightly orward, but at a sufficient distance from the desk to admit of free movements of the right arm in any direction: the left hand, when paper is used, rests on the left side of the paper to keep it steady: both shoulders are of the same height.

27. The chalk-holder is held between the two first fingers and thumb, not too stiffly, yet so as not to move between the fingers. The point of the chalk-holder may be from 1 to 1½ inch from the end of the thumb.

28. The two first fingers and thumb are each a little bent; the other fingers are turned slightly inwards, but not so tight as to cause the least constraint. The hand is supported on the fourth finger, so as to press very lightly with the chalk on the slate or paper.

29. In drawing lines horizontal, or nearly so, the fingers are stretched out nearly straight: the chalk-holder is held slanting back, and the horizontal motion is performed chiefly by the wrist, the fingers assisting slightly. In drawing lines vertical, or nearly so, the fingers are straightened to extend the chalk-holder upwards, and bent to bring it downwards; the line is in this case formed by the fingers and thumb only. Oblique lines and curves of every

description are drawn by the assistance of the fingers and the wrist together, the fingers being more or less bent according as the direction of the line to be drawn is more or less nearly vertical.

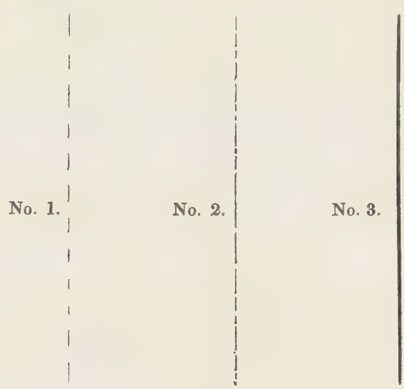
30. In general, the most convenient position for the hand in drawing any line is at right angles, or nearly so, to the direction of the line to be drawn.

31. In drawing long lines on the slate, the arm, hand, and wrist, may, when sufficient skill has been attained, be moved at the same time: for short lines, the movement is confined to the hand and fingers. Lines drawn on paper are drawn in short lengths by the movement of the hand and fingers only.

32. A facility of drawing good lines, whether straight or curved, at a single trial, is only to be acquired by an infinite number of acts; for beginners, and all who have not acquired that skill by long practice, the proper course to be followed in drawing chalk or pencil lines is as follows:—

1st. The direction of the line is found by dots marking its extremities and intervening points, as with No. 1.

2nd. The dotted line is filled in, and corrections are made, as with No. 2.



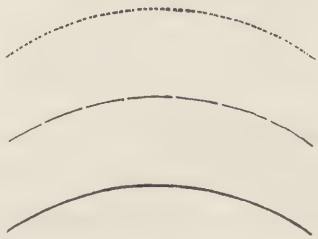
3rd. The line is finished, as with No. 3, so as to be of he same thickness throughout, and continuous*.

A similar process is followed for the drawing of a curve.

No. 1.

No. 2.

No. 3.



33. When paper is used in drawing, several sheets of paper, of any quality provided it be not creased or crumpled, should be placed underneath the sheet on which the drawing is to be made, otherwise the surface of the paper is too harsh for freedom of drawing, and any roughness that may exist on the surface of the desk beneath interferes with the straightness of the lines, or smoothness of the shades. The most convenient way to keep together these extra sheets of paper is to stitch them at the sides.

34. When the stump is used for shading over narrow surfaces, it is held in a manner similar to the chalk-holder, so as to touch the paper with the point, or nearly so: when it is used for shading over broad surfaces, it is held between the fingers and thumb in the same manner as a scraper, so as to touch the paper with the side.

* Continuous lines, of the same thickness throughout, are rarely used in drawing objects from nature; but, independently of their being required for the correct representation of the precise geometrical forms presented to the pupil in this method of drawing, it is to be observed that the mechanical power of drawing straight lines is the first that ought to be acquired and the last to be got rid of.

35. When shading, the pupil requires a piece of paper to place under his hand for the purpose of protecting the surface of the drawing, and also of trying the amount of chalk with which the stump is charged.

Duties of the Teacher.

36. The success of the teacher in imparting knowledge, as well as the gratification which he derives in the performance of his duties, are in a great measure proportionate to the degree of interest which he can induce the children to feel for the subject of instruction. With regard to the practice of drawing, the majority of children will look upon the lessons in the art as a recreation from more severe studies so long as they will be enabled to understand the principles set forth, or to apply them in practice; but the teacher may even incite his scholars to greater industry by showing in books the use of the art, "and informing them how much it assists the apprehension and relieves the memory, and if they are obliged sometimes to write descriptions of engines, utensils, or any complex pieces of workmanship, they will more fully apprehend the necessity of an expedient which so happily supplies the defects of language, and enables the eye to receive what cannot be conveyed to the mind in any other way."

Posture of the Pupils.

37. The teacher will find it most important to attend carefully to the posture of the pupils, and to the proper use of the fingers, from the earliest lessons.

Definitions.

38. When giving the definition of any line or figure, the teacher, not content with the verbal explanation, will take care to present to the class at the same time the wire or model corresponding to the definition.

Exercises on the Drawing Slates.

39. In providing for the course to be followed by the master in the inspection of the drawings, it is to be observed that the first series of exercises (those during which more frequent corrections will be required) consists exclusively of straight lines, whose apparent length and direction is modified by their position with reference to the spectator. Were the teacher to attempt to correct with his own hand the drawing of each pupil, as this would have to be done hastily, he would be liable, unless possessed of great skill, to draw the lines intended for the correction in a false direction: this process would moreover consume, in a mechanical operation that does not address itself to the judgment of the pupil, a time that would be much more beneficially employed in a verbal explanation so conveyed that the pupil should be enabled, by reference to some one of the rules, to detect the error, although he might not, from want of practice, succeed in correcting it at the first attempt. But in order to give weight to the verbal explanation, the master, having in his hand a straight wire painted white, and of such a length that it shall exceed the longest line to be drawn by the pupils, will give at the same time an

ocular demonstration, as follows: he will place the wire over the line to be corrected, so as to mark the proper direction and length of the line; should these be correct, but the line itself unsteady, a simple superposition will point out to the pupil the part that requires correction.

When the class has advanced to the drawing of curve lines, such as the circle, ellipse, &c., the master will then be unable, in correcting the drawings, to avail himself of mechanical assistance, similar to the above, owing to the infinite variations of curvature, caused by the foreshortening and other effects of perspective.

He will in these cases indicate with a mark made in white chalk, that part of the curve which is faulty, stating at the same time wherein the error consists; but he should not attempt to draw the entire curve himself on the pupil's slate, unless he feel perfect confidence in his ability to do so with rapidity and accuracy.

Exercises on Drawing Paper.

40. *Outline.* When the class shall have so far advanced as to draw on paper, corrections will not be so frequently required. For straight lines they will be shown in the same manner by the straight wire; and for curve lines the faulty places will be indicated in the same way by light marks made with the prepared charcoal, instead of white chalk. When the teacher at any time draws any portion of the model for the instruction of the pupil, he will take care to efface, after the explanation has been given, that part drawn by himself, in order that he may be able to test whether the pupil has rightly apprehended the explanation, and with the view also to train him to rely on his own exertions for success.

41. *Shading.* Errors in the shading will be pointed out by directing the pupil's attention to the play of light and shade on the model itself. The means of correcting the errors, either by increasing or diminishing the depth of shade, are explained in Chapter XII., when treating of the use of the stump.

42. The sanction of the master is necessary for the pupil to mark in crayon, the outline originally sketched in the prepared charcoal.

43. The pupils should be impressed with the necessity of guarding against the soiling and crumpling of the paper. The effect of shaded drawings, when seen by side light, is injured by the false shadows thrown by the raised parts of the paper if creased. In the description of the use of the stump, the pupil is directed to shade from left to right, and from top to bottom, in order to prevent any part of the shading from being rubbed by his hand or sleeve. This progression cannot always be adhered to; when departing from it, the pupil must take special care not to rub any of the shaded parts of the drawing.

44. The master will name a certain number of the most attentive pupils, upon whom will devolve the following duties, namely:—

1st. To supply each pupil with a drawing-slate, chalk-holder, and white chalk.

2nd. When drawing-paper is used, to supply each pupil with a sheet of paper, a chalk-holder with black and white chalks, a piece of prepared charcoal, one paper and two leather stumps, and a piece of chamois leather.

3rd. To write in the upper left hand corner of the sheet of paper, the name of the pupil and the date.

4th. To collect the slates, papers, crayons, &c., at the end of the lesson.

5th. To put back all the materials in their places, as described in Nos. 11 to 16.

45. In the directions conveyed in the Manual, with reference to the positions to be given to the models, they are supposed to be placed opposite the middle of the room, except when otherwise specified.

46. The master will, when practicable, always place the model to be copied in front of a black board, or dark cloth, in order that its contour may be seen with greater facility by the class.

47. With each new model presented to the class, whether it be of wire, or one representing a solid form, the teacher will refer briefly to the principles, by the help of which it is to be drawn in outline, or shaded.

48. When the class has commenced to draw from the solid models, it will generally be useful for the teacher to sketch the outline on the black board, on a scale sufficiently large to enable him to mark distinctly, by dotted lines, the lines of construction required for the more systematic delineation of the figure.

49. When the class has commenced to draw on paper, the master will have one or more drawings of each model about to be copied, to be occasionally referred to for the purpose of showing the style in which the drawing is to be performed, as also the mode of progress; but these original drawings are to be referred to solely for the purpose of occasional inspection. They will be required only for the first ten or twelve drawings, after which the pupils will

have acquired a sufficient knowledge of the style to need no other assistance than the indication of the lines of construction, as explained in No. 48.

50. When the class has commenced shaded drawings, the model, of which the delineation is in progress, may, at the commencement of a new lesson, be replaced exactly in the same position as that occupied in the preceding lesson, by reference to the drawings of two or more pupils placed at different sides of the class-room.

51. When a drawing class exceeds twenty or twenty-five pupils, we would recommend the master to devote some extra time to the teaching of several of the most skilful and intelligent, who might in their capacity of monitors assist him materially in the conducting of the class after the pupils had commenced to draw on paper. These monitors would execute the drawing of each model like the other pupils, but, from their superior skill, they would complete the drawing before the remainder. The spare time could then be devoted to the examination and partial correction of the drawings of those pupils who would be less advanced.

52. With respect to the time to be devoted in schools to the cultivation of drawing, we would recommend that not less than three hours each week be set aside for its pursuit. But we would suggest that, in those establishments in which it could be accomplished without interfering with more important studies, the pupils should devote one hour each day to drawing.

EXPLANATION OF THE PLATES.

The Plates are designed chiefly to show the succession of the Models arranged in the synthetic order in which they are to be presented to the Class. They will likewise assist the teacher in his observations of the effects of light and shade. They are never to be used by the pupils as copies.

PLATE I.

THE MODEL-STAND AND EYE-MODEL.

(See Frontispiece.)

FIG. 1, THE MODEL-STAND;—an instrument provided with sliding pieces similar to the sliding tubes of a telescope, with a clamp for holding the model, and an universal joint, by the movement of which the model may be placed in varying perspective. In the figure, the icosahedron is represented upheld by means of the clamp of the model stand, which catches a projecting spur let in on each model as required.

This Model-Stand is, with slight modifications, like that used and invented by Dupuis, and by him called the "Polyschématiste."

FIG. 2 represents, on a larger scale, the CLAMP, the UNIVERSAL JOINT, and a part of the Inner Sliding Tube of the Stand. The universal joint may be separated from the stand, by loosening the thumb-screw *a*.

FIG. 3 represents the same Stand, with the universal joint removed, and the Eye-Model substituted in its place. The eye-model is made so that it may be turned with ease in any direction:—the threads diverging from the eye support a weight, by the action of which, in the interior of the tube, they are always kept stretched when the demonstration wire and the threads are required for the investigation of the rules of perspective.

FIG. 4 represents, on a larger scale, the inside of the Eye-Model, for the purpose of showing the arrangement of the pulleys, threads, and the mode of working of the weight.

FIG. 5 represents the Model-Stand in a form more convenient for packing. The inner sliding tube is inclosed in the exterior tube, or shaft of the stand; and the tripod or legs of the model are separated from the shaft, and laid close to each other.

FIG. 6 represents, on a larger scale, the lower part of the Stand, into which the upper parts of the legs or tripod are let in, and to which they are held fast by means of the thumb-screw *b*.

FIRST SERIES.

WIRE MODELS OF STRAIGHT LINES AND CURVES.

(*Wire Models were first used by Dupuis.*)

PLATE II.

No. 1 Straight Line, used as a Model and a Demonstration Wire.

2 Right Angle.

3 A Straight Line raised at Right Angles from the middle of another Straight Line.

4 Two Straight Lines bisecting each other at Right Angles

5 Acute Angle.

6 Obtuse Angle.

7 Right-angled Triangle.

8 Equilateral Triangle.

9 Isosceles Triangle.

10 Square.

PLATE III.

No. 11 Star.

12 Pentagon.

13 Hexagon.

14 Heptagon.

15 Octagon.

16 Decagon.

17 Arc.

18 Arc and Secant.

PLATE IV.

No. 19 Arc and Tangent.

20 Three Arcs, vertically equi-distant from one another.

21 Two equal Convex Arcs, bounded by a straight line.

22 Two equal Concave Arcs, bounded by a straight line.

23 Two equal Convex Arcs, open.

24 Two equal Concave Arcs, open.

25 Triangle formed by Concave Arcs.

26 Spherical Triangle.

27 Circle.

28 Ellipse.

SECOND SERIES.

SOLID MODELS OF RECTILINEAR FORMS.

PLATE V.

No. 1 Cube, or Hexahedron.
2 Parallelopipedon.
3 Quadrangular Pyramid.
4 No. 1 and No. 3 combined.
5 Wedge.
6 No. 1 and No. 5 combined.

PLATE VI.

No. 7 Hexagonal prism.
8 Tetrahedron.
9 Octahedron.
10 Square frame (the bars flat).
11 Form similar to No. 5, with the inside hollowed out.
12 Two square bars meeting at right angles.

PLATE VII.

No. 13 Square Frame (the bars square).
14 Square Frame (the bars flat).
15 Triangle (the bars square).
16 Composed of No. 13 and No. 17.
17 Cross.
18 Steps.
19 Square Frame (the bars triangular).
20 Pentagon (the bars square.)
21 Octagon (the bars square).

THIRD SERIES.

SOLID MODELS OF RECTILINEAR AND CURVED FORMS.

PLATE VIII.

No. 22 Frame (bevil-edged).
23 Star (the bars rectilinear).
24 Hexagon (the bars square).
25 Cubical Hollow Chamber (part of No. 1).
26 Rectangular Hollow Chamber (part of No. 2).
27 Lid of No. 1.
28 Lid of No.

PLATE IX.

No. 29 Cylinder.
30 Right Cone.
31 Oblique Cone.
32 Frustrum of a Cone.
33 Quadrant.
34 Circular Hoop.
35 Curved Triangle.
36 Composed of No. 13 and No. 34.
37 Composed of No. 13 and the repetition of form No. 34.
38 Globe.

PLATE X.

No. 39 Ellipsoid.
40 Dodecahedron.
41 Icosahedron.
42 Hollow Cube (Cube *évidé*).
43 Hollow quadrangular Pyramid.
44 Composed of No. 42 and No. 43.
45 Composed of No. 13 and No. 17.

FOURTH SERIES.

SOLID MODELS OF CURVED AND COMBINED FORMS.

PLATE XI.

No. 46 Hollow Hexagonal Prism.
47 Hollow Hexagonal Pyramid.
48 Composed of No. 46 and No. 47.
49 Part of Column composed of No. 29, No. 50, and No. 51.
50 Fillet and Cavetto (hollowed).
51 Bead Moulding.

PLATE XII.

No. 52 Star (bars curved).
53 Hexagon formed with cylindrical bars.
54 Moorish Pillar, composed of No. 7, No. 24, and No. 53.
55 Circumference of Wheel.
56 Drum Wheel, composed of No. 55 and No. 57.
57 Spokes.

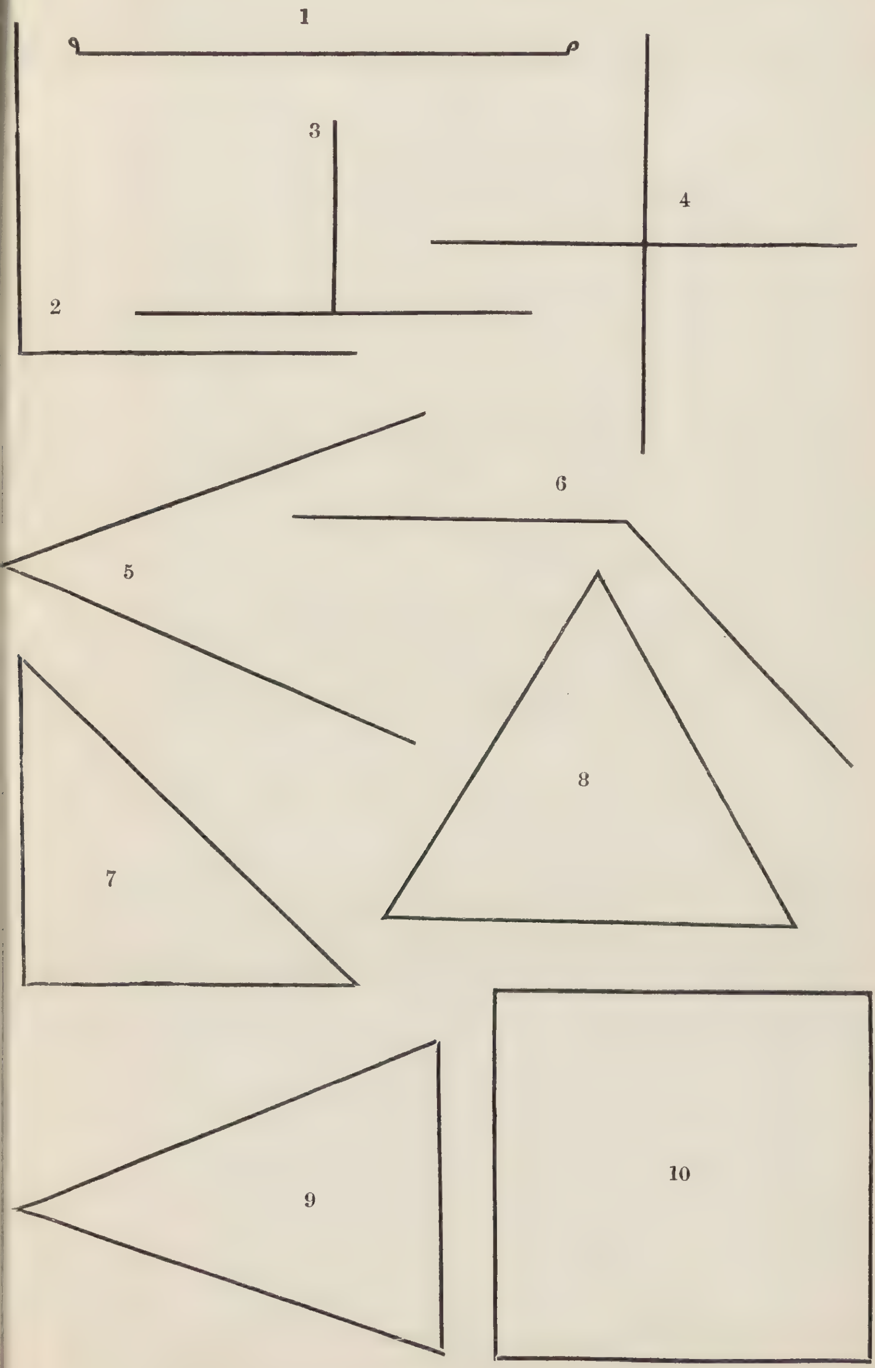
PLATE XIII.

No. 58 Composed of No. 13 and No. 34, to be joined at any angle relatively to one another.
59 Pedestal and part of Column, composed of Nos. 1, 5, 10, 11, 14, 19, 22, 29, 50, and 51.
60 Screw (angular thread).
61 Screw (square thread).

PLATE XIV.

No. 62 Circumference of Toothed Wheel.
63 Toothed Wheel.
64 Wreathed Column.
65 Chain
65 Bevil-Wheel.

WIRE MODELS OF STRAIGHT LINES AND CURVES.



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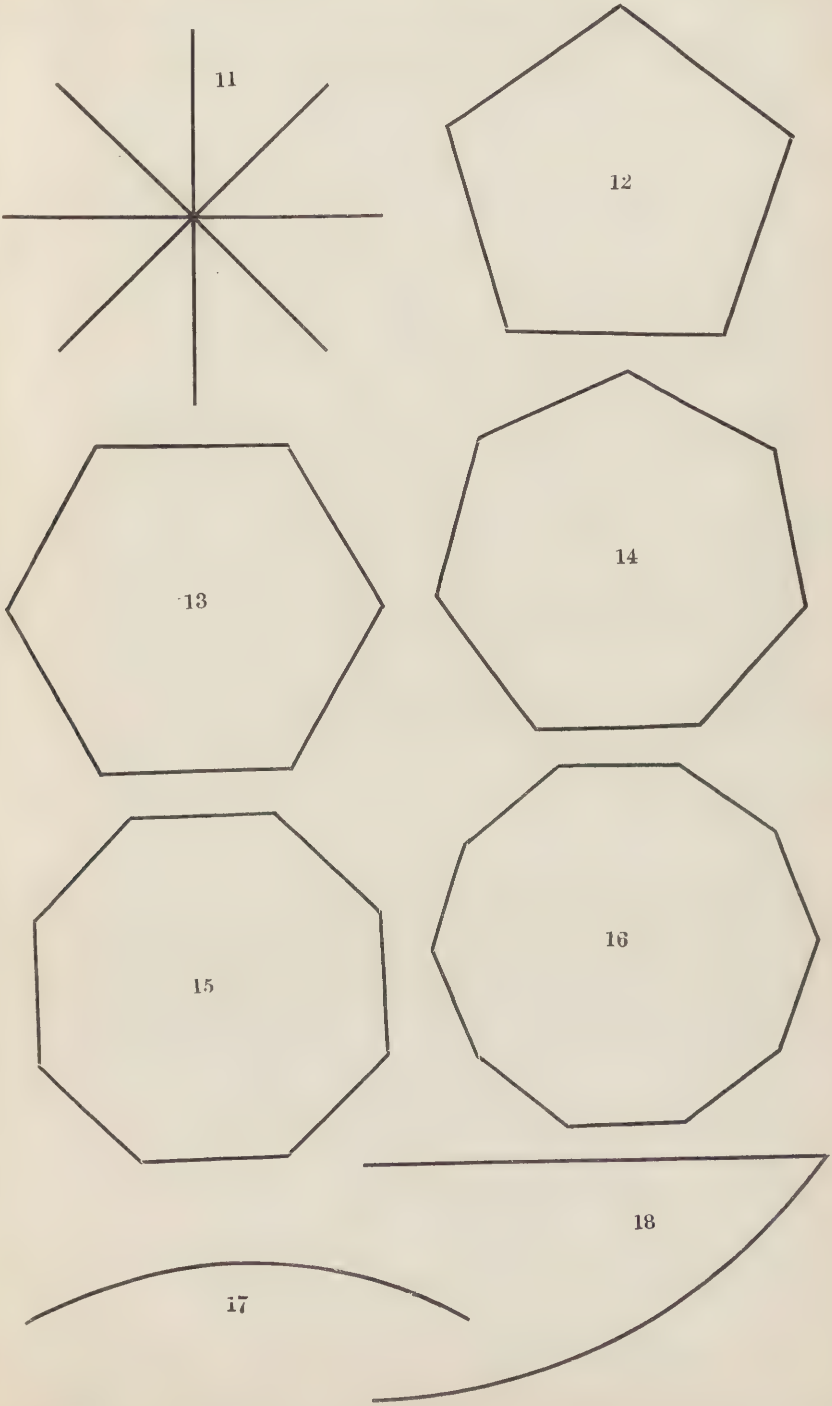

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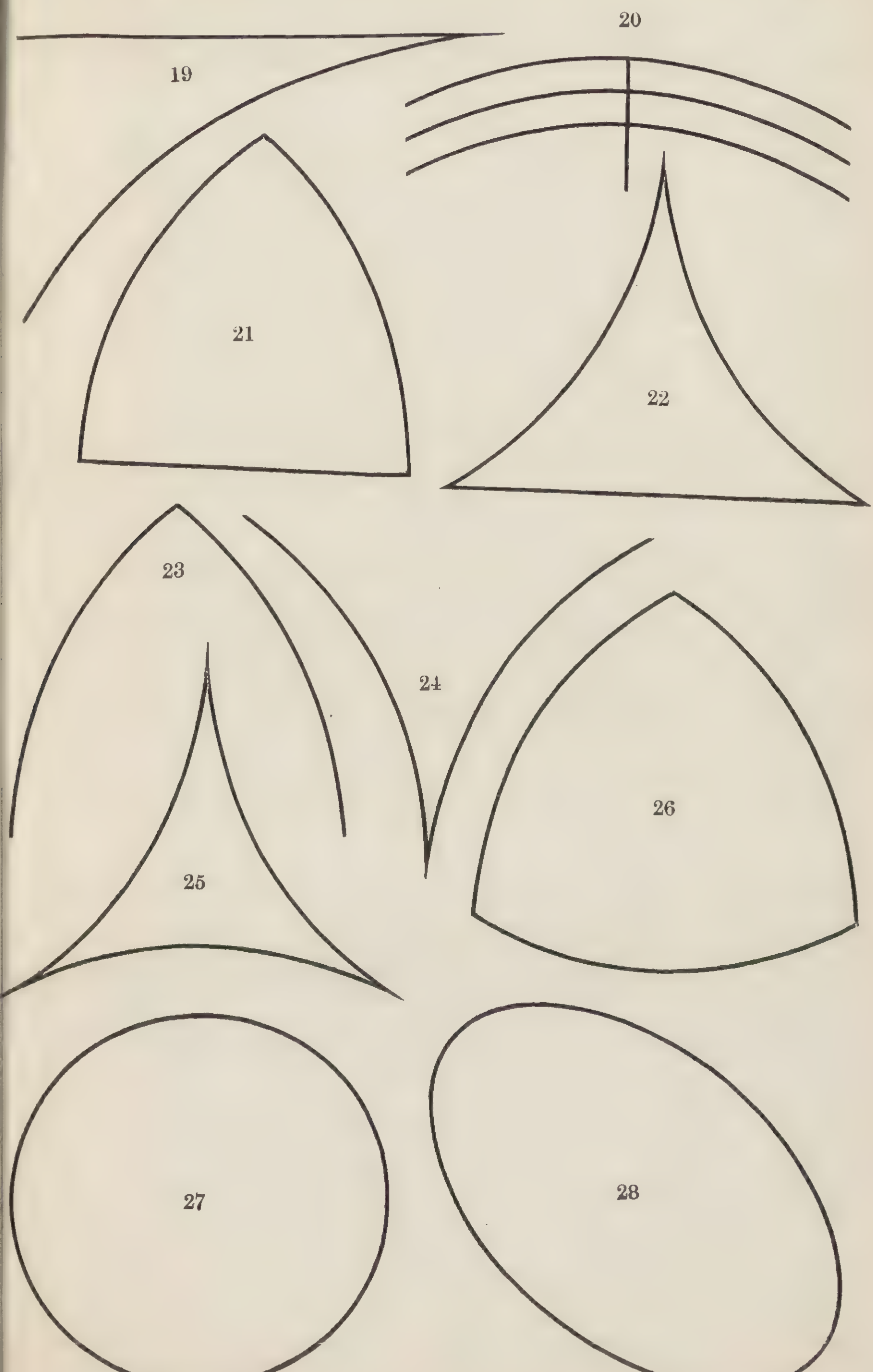

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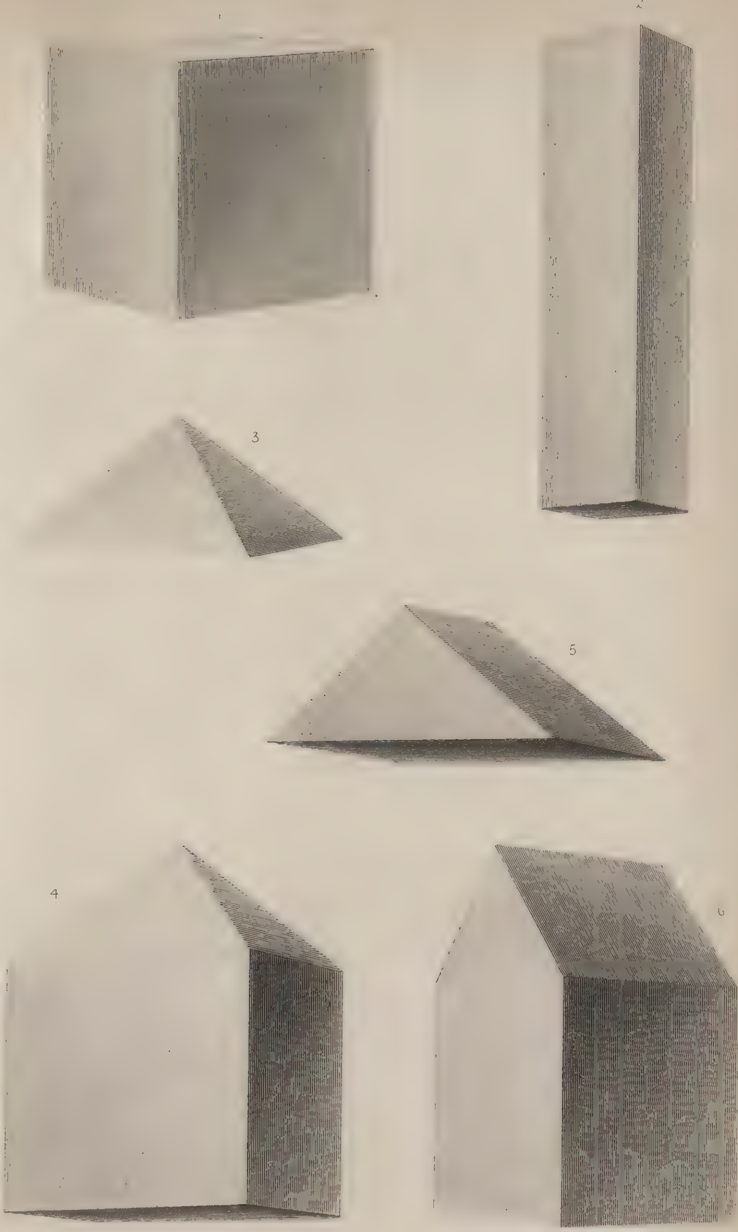

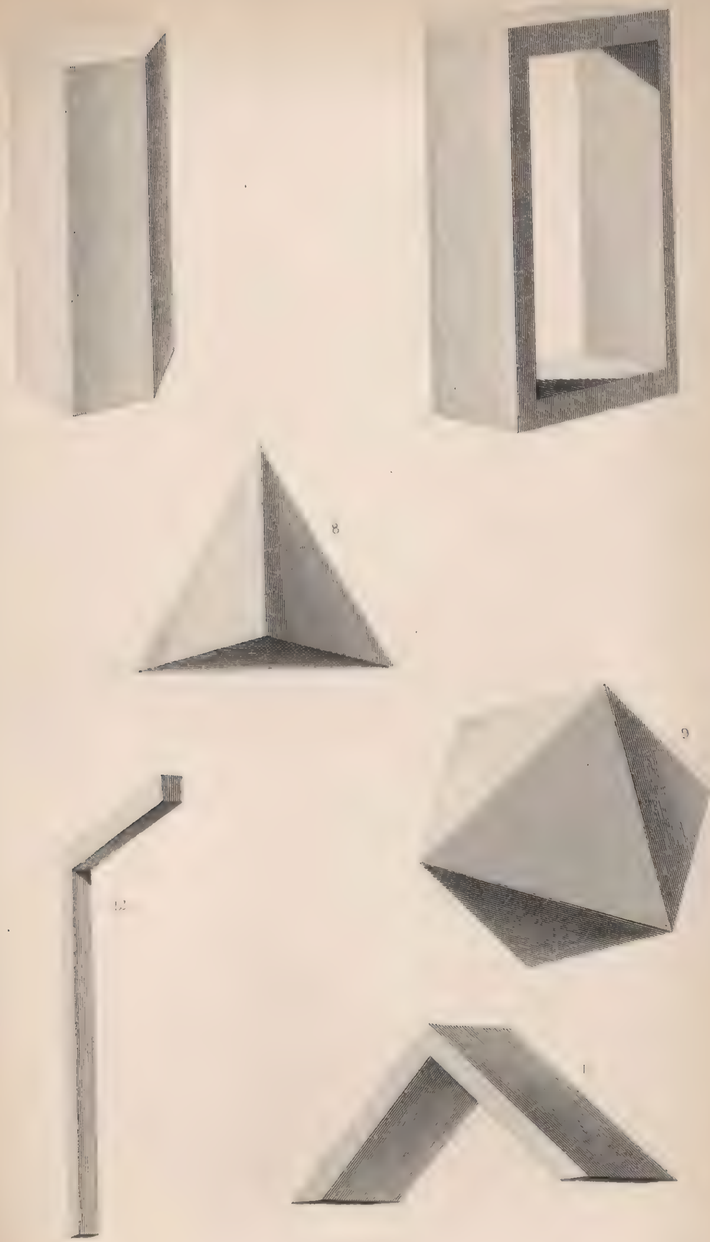

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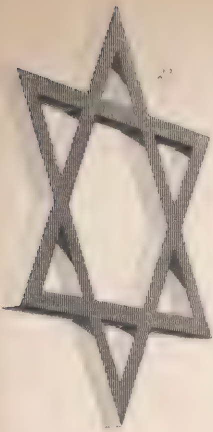

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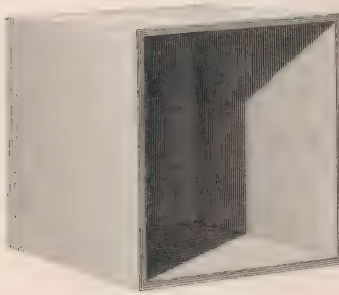

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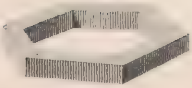

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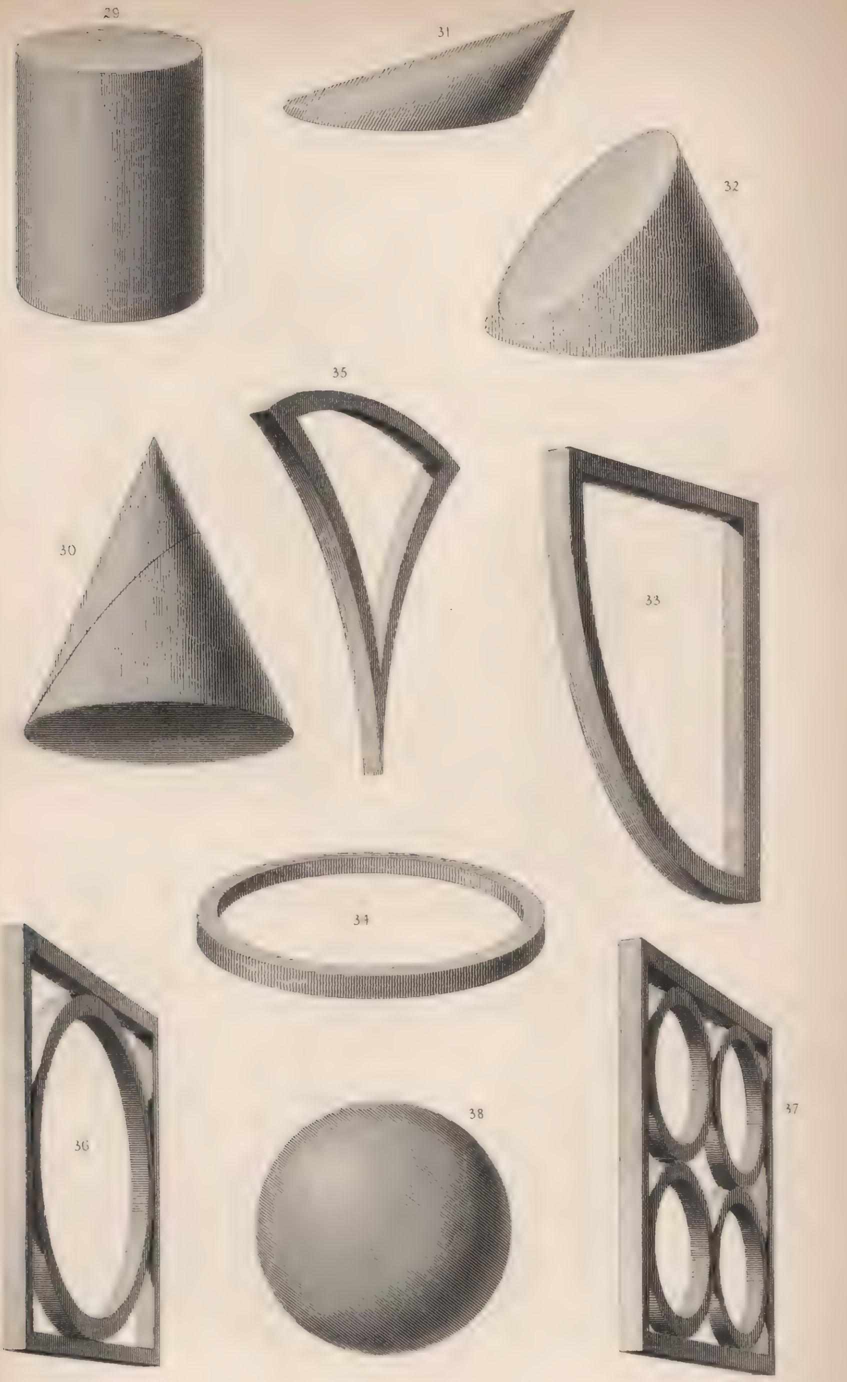

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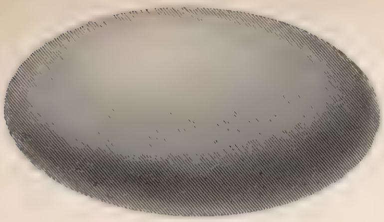

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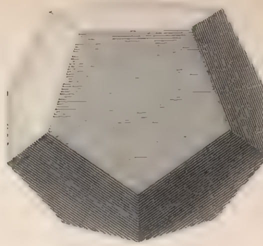

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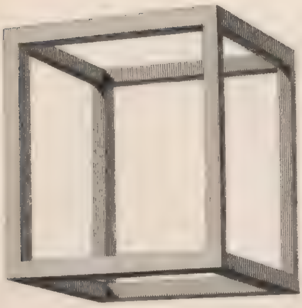

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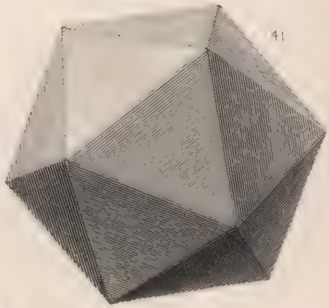

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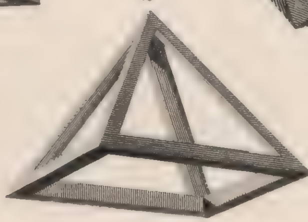

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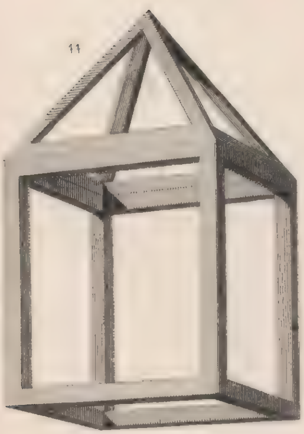

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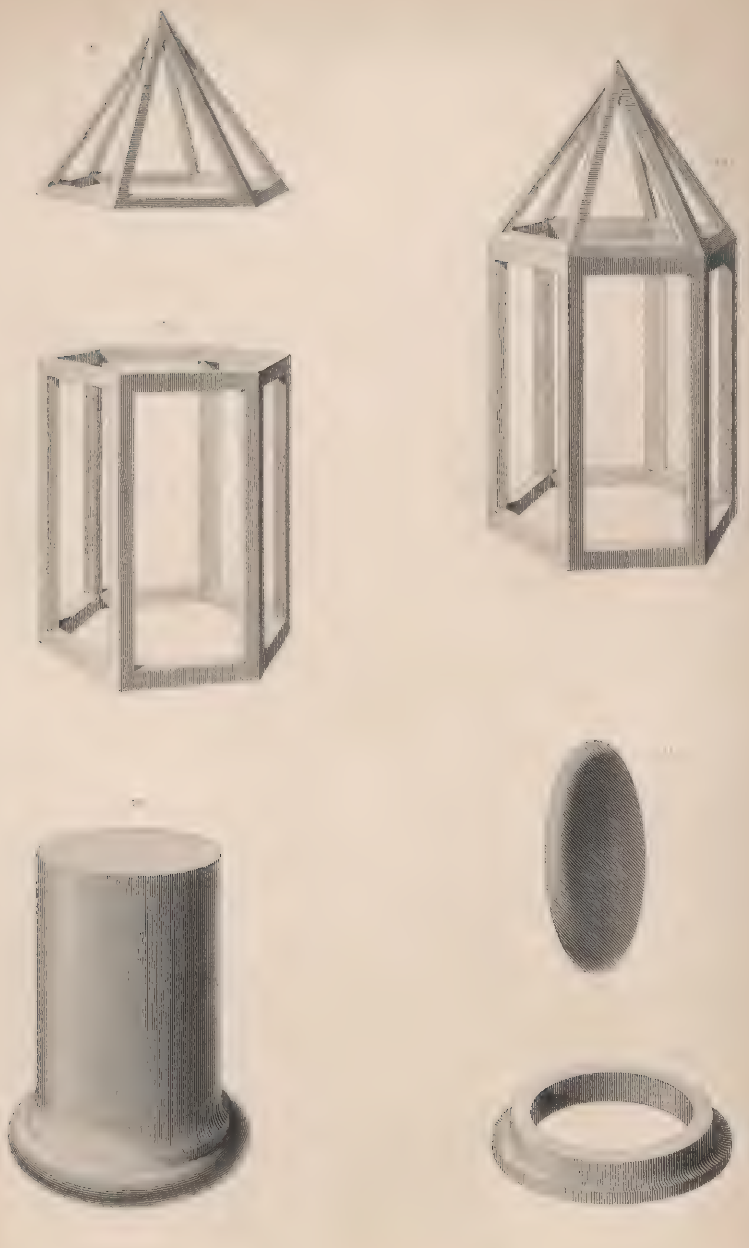

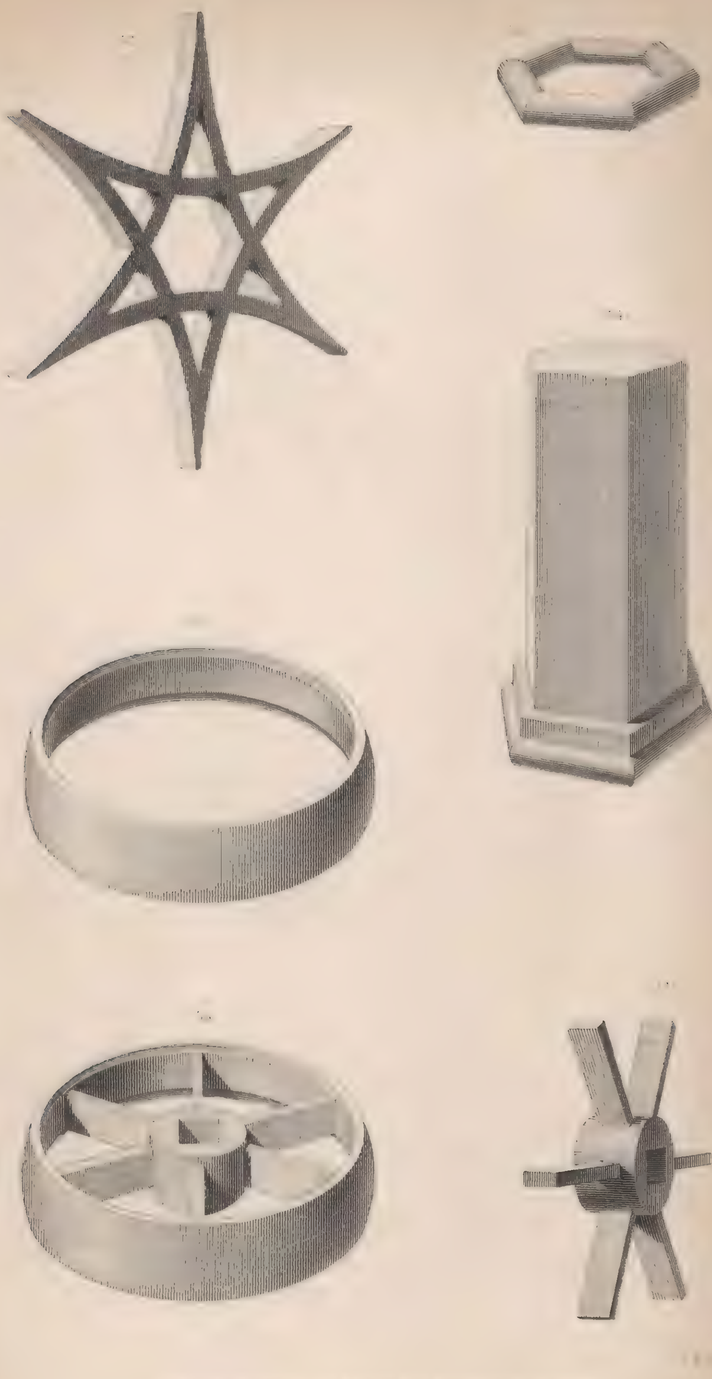

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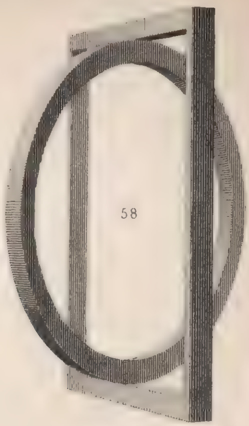
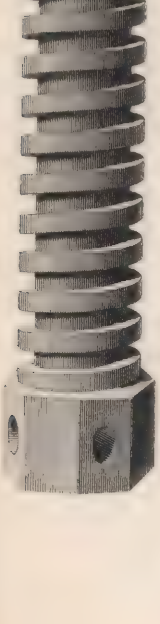


58

59



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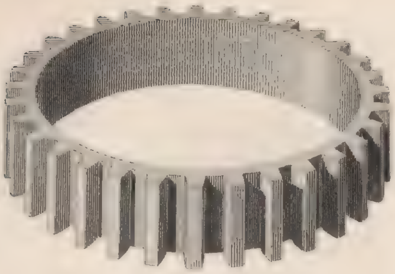
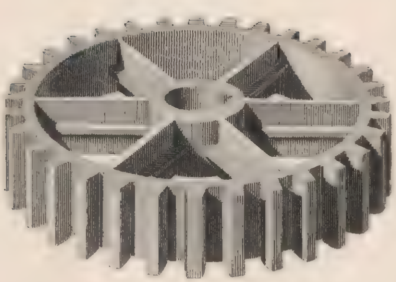
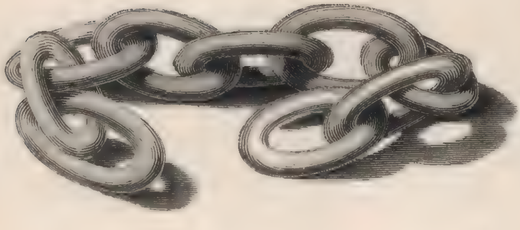


64

63



65



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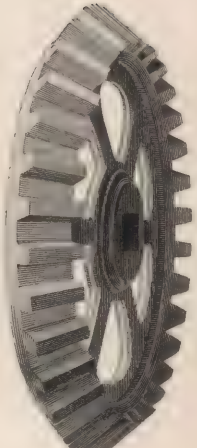

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THE

Classical Museum.

CONTENTS OF PART I.

For some years past it has been the cause of much regret among our own scholars, as well as among those of foreign countries, that there has existed no organ for the discussion and illustration of a branch of knowledge—the knowledge of antiquity—which once was, and to some extent still is, the pride of our country. Latterly our scholars have had no direct means of communicating with one another, or of becoming acquainted with one another's labours. The great Reviews, for obvious reasons, seldom notice works relating to classical antiquity; and the consequence has been that works of acknowledged merit in this department of literature have rarely received that share of public attention which they deserve, and have sometimes remained unknown to the great body of classical students. The same has been the case, but to a much greater extent, with the productions of continental scholars. Foreign countries have had still fewer opportunities of learning how classical studies were faring with us, and a pretty general belief has arisen that classical studies here were decaying or nearly extinct. Now although it cannot be denied, that at a recent period of our literary history there has been a falling off in classical studies, or perhaps, more correctly speaking, in the production of great and standard works, and that we who used to take the lead in these matters, are now in a great measure led by others, yet it is at the same time an indisputable

fact, that within the last twelve or fifteen years the study of classica antiquity has been reviving among us, and that its importance in education and in the cultivation of the mind and of taste in general, has been more universally recognised.

Several attempts have been made within the last few years to fill up the existing deficiency in our periodical literature, and to establish a journal devoted to classical antiquity, but various difficulties have from time to time prevented the realization of the plan. These difficulties are now overcome, and owing to the generous support which the Editor has received from many distinguished scholars, the final arrangements have been made for the publication of the **Classical Museum**, and the first part is now ready. It is hoped, that the scholars of this country will unite in lending their assistance in establishing and supporting a journal, the want of which has been felt painfully by all who take an interest in classical pursuits.

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